

**ALABAMA SUPPLEMENTS TO THE  
NATIONAL ENGINEERING FIELD HANDBOOK**

**CHAPTER 11. PONDS AND RESERVOIRS**

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## **PART I - GENERAL**

### **3. TYPES OF PONDS AND RESERVOIRS**

Classify embankment ponds according to the National Engineering Manual, Alabama Engineering Job Approval Authority, AL-ENG-1. Secure design criteria from NRCS Conservation Practice Standard Code 378, Pond and the following table:

Job Class <sup>1/</sup>	Principal Spillway (Storm 24 hour) or Detention Storage	Design Storm (24 hour) Emergency Spillway	Top of Dam or Freeboard Elevation
	years	years <sup>2/</sup>	years <sup>3/</sup>
I	0.5 <sup>4/</sup>	10	50
I	1 <sup>4/</sup>	25	50
II	2	25	50
III <sup>5/</sup>	5	50	50
IV <sup>6/</sup>	10	50	50
V	10	50	50

See NRCS Conservation Practice Standard, Code 378 - Pond for Footnotes.

TABLE AL11-1. MINIMUM HYDROLOGIC CRITERIA AND SPILLWAY CAPACITY



## **PART II - EMBANKMENT PONDS**

### **1. GEOLOGIC INVESTIGATIONS**

#### **RECORDS OF SOILS INVESTIGATIONS**

A permanent record of all soil boring and test pits made will be maintained in the field office. Form SCS-ENG-538, AL-ENG-17 will be used to record soil borings on earth fill ponds and excavated ponds. Questionable sites and those requiring an engineer's approval will be recorded on SCS-ENG-538.



#### **4. PRINCIPAL SPILLWAYS**

##### **DROP INLET SPILLWAYS**

###### **Design**

The design capacity of a principal spillway will be adequate to discharge long duration, continuous, or frequent design flows without flow through the emergency spillway. Table AL11-2, Figure AL11-1, AL11-2, and AL11-3, or an approved computer design program will be used to size the principal spillway and set the crest of the emergency spillway. For siphon pipes, assume full pipe flow when the reservoir surface elevation is D/3 above the high point of a siphon invert. Outlet slopes must be maintained at design grades until a suitable outlet is reached.

Table AL11-3 and AL11-4 or an approved computer program should be used to determine the buoyant forces on riser pipes.

Exhibit AL11-1, AL11-2, and AL11-3 show typical examples of trash racks and deep water releases. Form AL-ENG-4A may be used (with slight modifications) to design ponds with siphon principal spillways.



## **5. EMERGENCY SPILLWAYS**

Emergency spillways can be designed utilizing Exhibit 11-2, 11-5, or an approved computer design program.



## **7. DESIGN OF EARTHFILL EMBANKMENTS**

The following definition and example shows how to use the tables and exhibits in the design and recording of data on Form AL-ENG-4A, POND DESIGN DATA, Figure AL11-4. Form AL-ENG-4A, or the WinPond, current version, shall be used on all engineering Class I and higher ponds which meet the Technical Guide Standard, Code 378 - Pond criteria.

**Job Class** - determined from the criteria listed on Form AL-ENG-1, ENGINEERING JOB APPROVAL CLASSIFICATION CHART in the National Engineering Manual. The actual JOB CLASS is determined by the largest controlling factor. Most of these can be determined from office data, with the effective height of dam determined from field surveys.

**Soils** - obtained from the soils map of the pond area and refers to the soils in the watershed. When several soils and land uses exist, use Form AL-ENG-15, Worksheet for Detention Discharge for Ponds.

**Hydro.Gr.** - Hydrologic Group - obtained from Chapter 2 or Technical Release 55.

**Land Use** - refers to the type of land use in the drainage area (Row Crop, Pasture, Woods, etc.).

**Trtmt.** - refers to the treatment or practice and cover type on the land use.

**Condition** - Hydraulic condition of the cover in the watershed (poor, fair, good).

**Rainfall Dist. Type II or III** - Circle the type rainfall distribution used for design.

**DA** - Drainage Area (acres) - determined by scale or planimeter from stereoscopic or soil maps. Critical drainage areas should be drawn from the contours on U.S.G.S. topographic maps and planimetered.

**CN** - Curve Number - a numerical value assigned a given soil-cover complex. (See Chapter 2).

**W/S Slope** - Average Watershed Slope - the average watershed slope (percent) over the entire watershed can be approximated by measuring the slope at several random locations throughout the watershed and averaging the results. The average watershed slope should be in line with slopes identified in the soil survey.

**Flow Length** – Length in feet along the flow path from the hydraulically most distant point to the pond dam.

**Tc** – Time of concentration for the watershed.

**Rainfall (ps) or Rainfall (ES)** - \_\_\_\_\_ in. \_\_\_\_\_ yr. - the rainfall amount and duration of event used in the dam design for the principal spillway or emergency spillway. (See Table 7 in NRCS Conservation Practice Standard, Code 378, Pond, for the storm event for the class of pond.)

**Ia** – Initial abstraction (See Chapter 2).

**Ia/P(ps)** – Ratio of Initial abstraction to design principal spillway storm.

**Qpeak(ps)** – Unit peak discharge for the principal spillway storm.



V<sub>r</sub> - the volume of runoff in inches from the principal spillway storm that must be stored between the riser crest and emergency spillway crest and/or passed through the principal spillway pipe. Obtain the inches of runoff for the rainfall amount and CN. (See Chapter 2).

Q<sub>i</sub> (ps) - the peak inflow to the pond from the principal spillway storm.

V<sub>s</sub> - the volume of floodwater storage available in the pond between the permanent pool elevation and the emergency spillway crest elevation in Ac-Ft. Obtain by averaging the area at the principal spillway crest and the emergency spillway crest, then multiplying by the elevation differences between the two areas. Surveys for determining pool areas will be documented in the survey notes or case file.

V<sub>s(in.)</sub> - the volume of storage in acre-feet converted to inches. To convert, multiply \_\_\_\_\_ acre-feet x 12, then divide by the drainage area \_\_\_\_\_ acres, which give \_\_\_\_\_ inches.

Tab A or B - Circle whether using Table A or B as defined in Figure 1, Exhibit 11-4.

Q<sub>o</sub> (ps) - The peak discharge for the principal spillway pipe (Table A or B, Exhibit 11-4).

(A) Value from Table x Q<sub>i</sub> (ps) cfs = \_\_\_\_\_ cfs (Exhibit 11-4)

(B) Value from Table x DA acres = \_\_\_\_\_ cfs (Exhibit AL11-4)

H - Head in feet from emergency spillway crest to center of outlet end of barrel pipe or tailwater elevation.

Pipe Size - records the riser and barrel diameters as determined from Table AL11-2 using Q<sub>o</sub> (ps) and (H) head in feet.

I<sub>a</sub>/P(es) – Ratio of initial abstraction to design emergency spillway storm.

Qpeak(es) – Unit peak discharge for the emergency spillway storm.

R.O. (es) – Runoff in inches for the emergency spillway storm.

Q<sub>es</sub> - The peak flow for the emergency spillway storm.

Q<sub>es</sub> (design) - The design flow for the emergency spillway.

Erosion Resistant Soil Yes or No, Circle One - Erosion Resistant Soils normally are considered to be hydrologic soil groups C & D and heavy B soils. Easily eroded soils are A and weak B soils.

Cover - Record the vegetation that will be established in the bottom of the emergency spillway.

Conditon Stand - From knowledge of landuser and visual observation of conditions around the farm determine conditions of vegetation to be fair or good.

Height - Determine an expected average height of vegetation. Record the heights for stability and capacity.

Slope - The average slope that can be secured in the emergency spillway exit channel.

Vel. - Determine from Exhibit 11-2, Table 1, the maximum permissible velocity in fps for the vegetated spillway using erosion resistant soil or easily eroded soil, cover vegetation and slope of exit channel.

Retardance: Stability - \_\_\_\_\_ capacity \_\_\_\_\_ - determine degree of retardance from Exhibit 11-2, Table 2, using condition of vegetation stand and average length (height) of vegetation.



**Control-Section Length** - The minimum length is determined from visual observation or determined from a plotted profile of the emergency spillway centerline (minimum 25 ft.).

**q/ft** - Discharge per foot width of the emergency spillway. For example, using retardance C enter Exhibit 11-2, Table 3A-3E. From left side of Table 3C at maximum velocity  $V = 7(6)$ , 4% slope (slope range 1-12). Determine discharge of 4 cubic feet per second per foot of width.

**S/W BW** - The bottom width of the emergency spillway (ft.) is determined by dividing the emergency spillway discharge  $Q_{es(design)}$  by  $q/\text{ft}$ .

**H<sub>p</sub>** - The design depth of water in the reservoir above the crest of the emergency spillway.

**SW/SS** - The side slopes of the emergency spillway.

**Exit Slope Range** - Slope range is determined from Exhibit 11-2, Table 3C, as in discharge  $q/\text{ft}$ . above.

**Adequate** - Yes or no applies when you have or need to analyze for stability and capacity both using different retardance.

**Embankment SS** - The side slopes of the embankment.

**Freeboard** - A safety factor applied as an elevation above the designed elevation of flow ( $H_p$ ) in the emergency spillway. (See NRCS Conservation Practice Standard Code 378, Pond.)

**Flotation** - Cubic feet of concrete required to counteract flotation (buoyancy) of the riser pipe.  
(See Table AL11-3, Table AL11-4, or use approved computer program.)

**GENERAL INFORMATION** or other information - describes items particular to a specific site and survey. These items are self-explanatory. Earth fill quantities are computed using Exhibit 11-6 or Table AL11-5 or an approved computer program.

The final design to be given to the landowner will include a Plan of Pond (AL-ENG-2 for a Class I or II pond, AL-ENG-3 for a Class III thru V pond), an AL-ECS-1 for critical area planting, and an Operation and Maintenance Plan for all dams. Prior to completing the final design of a Class I or larger embankment pond, Form AL-ENG-27 or 27a must be executed by the landowner. [See NEM, Part AL501.04(a) Exhibit 2.]

Figures AL11-4 present sample sets of construction layout notes for an embankment and earth spillway. Design, layout, and check notes may be recorded on approved standard forms or data sheets.

Figure AL11-5 presents a sample set of construction check survey notes for embankment ponds.

The following worksheets are shown for use as guides in determining class of structure, length of pipe, pipe buoyancy, anti-seep collars, and drawdown time for total pond drainage or drawdown to seizable depth.

## **FOUNDATION CUTOFFS**

The cutoff trench shall have a bottom width of at least 8 feet with side slopes of 1.5:1 or flatter.



## WORKSHEET FOR PONDS

### DETERMINE CLASS OF STRUCTURE

Effective height of dam\*: \_\_\_\_\_ ft. - \_\_\_\_\_ ft. = \_\_\_\_\_ ft.      CLASS \_\_\_\_\_

\*(Elev. Crest of emer. Spillway) - (Elev. Low point along centerline)

Conduit size \_\_\_\_\_ inches      CLASS \_\_\_\_\_

Pipe conduit capacity \_\_\_\_\_ CFS      CLASS \_\_\_\_\_

Auxilliary spillway flow \_\_\_\_\_ CFS      CLASS \_\_\_\_\_

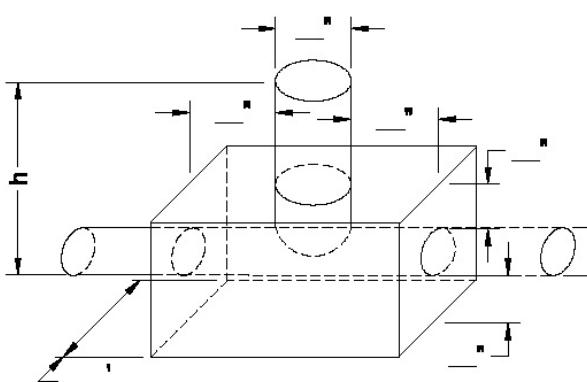
Drainage area \_\_\_\_\_ ac.      CLASS \_\_\_\_\_

Storage =  $(0.40) \times (\text{_____ acres}) \times (\text{_____ depth}) = \text{_____ ac. ft.}$

\_\_\_\_\_ ac.ft. x \_\_\_\_\_ ft. = \_\_\_\_\_ ac. ft.      CLASS \_\_\_\_\_  
Storage                          Eff. Height

Total Storage \_\_\_\_\_ ac.ft.      CLASS \_\_\_\_\_

### DETERMINE PIPE BUOYANCY



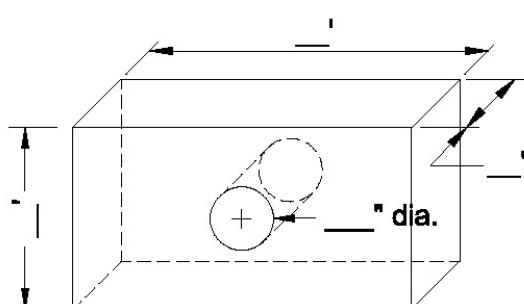
$$\begin{aligned} h &= \text{_____ ft.} \\ W &= \text{_____ lbs./lin.ft.} \\ B &= \text{_____ lbs./lin.ft.} \end{aligned}$$

Required vol. of concrete for concrete pad.

$$\frac{(B - W) h}{87.6} = \frac{(\text{_____} - \text{_____}) \text{_____}}{87.6}$$

$$= \text{_____ ft}^3$$

### DETERMINE ANTI-SEEP COLLARS.



Fill Ht. = \_\_\_\_\_ top dam - \_\_\_\_\_ Invert pipe of dam

ASC's Required = \_\_\_\_\_ (See Table 6)

Type Collars \_\_\_\_\_

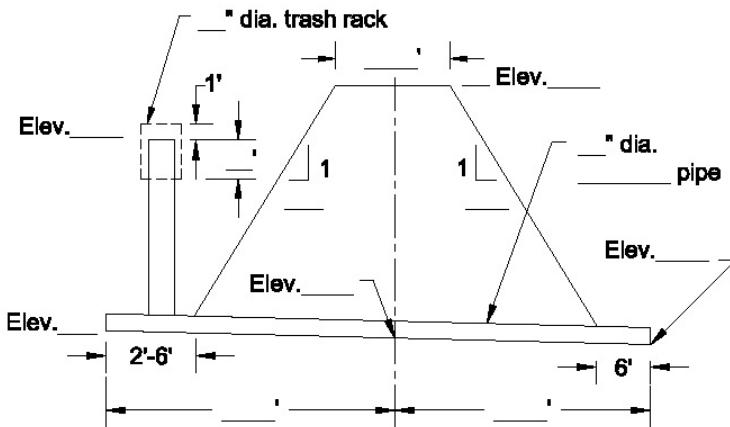
If concrete, volume needed = \_\_\_\_\_

Total Concrete Volume = (Pad) \_\_\_\_\_ C.F. + Anti-seep Collar \_\_\_\_\_ C.F. = \_\_\_\_\_ C.Y.



## WORKSHEET FOR PONDS

### DRAIN PIPE LENGTH CALCULATIONS



#### DRAW DOWN TIME FOR TOTAL POND DRAINAGE

(1) Total pond capacity

$$\text{Hill pond} = (0.40) \times (\text{_____ acres}) \times (\text{_____}' \text{ depth}) = \text{_____ ac.ft.}$$

$$\text{Levee pond} = (\text{_____}' \text{ Max} + \text{_____}' \text{ Min}) \times (\text{_____ acres}) = \text{_____ ac.ft.}$$

$$(2) \text{ Avg. depth pond} = \frac{\text{_____ Max. depth ft.}}{2} = \text{_____ ft.}$$

$$(3) \text{ _____ " } \frac{\text{---' + ---'}}{2} \text{ will carry } \text{_____ ac.ft./day}$$

$$(4) \text{ Time} = \text{_____ (1) / } \text{_____ (3)} = \text{_____ days}$$

#### DRAWDOWN TIME TO SEINEABLE DEPTH (3 days or less)

$$(1) \text{ Max. depth @ riser} = \text{_____ ft.}$$

$$(2) \text{ Pond acres full} = \text{_____ ac.}$$

$$(3) \text{ Pond acres @ 7. ft. max. depth} = \text{_____ ac.}$$

$$(4) \text{ Depth drained} = \text{_____ (1) - 7. ft.} = \text{_____ ft.}$$

$$(5) \text{ Volume drained} = [(\text{_____ (2) + } \text{_____ (3)}) \times \text{_____ (4)}] = \text{_____ ac.ft.}$$

$$(6) \text{ Avg. head on barrel} = [(\text{_____ (1) - 7 ft.}) \times 7 \text{ ft.}] = \text{_____ ft.}$$

$$(7) \text{ _____ " barrel pipe @ (6) will carry } \text{_____ ac.ft./day.}$$

$$(8) \text{ Time} = \text{_____ (5) / } \text{_____ (7)} = \text{_____ days}$$



## **PART III - EXCAVATED PONDS**

### **5. PLANNING AN EXCAVATED POND**

#### **SELECTING POND DIMENSIONS**

Water needs for cattle, Table AL11-6, and seepage and evaporation losses, Table AL11-7, are used to determine capacity of storage required. Use storage required and appropriate sheets of Table AL11-8 for dimensions of excavated ponds. As an alternative method, Table AL11-4 for dimensions of excavated ponds. As an alternative method, Table AL-4 can be used. This table has seepage and evaporation losses already subtracted and the excavated pond size can be determined by the Total Water Needs for the Cattle. Where an excavated pond is fed from ground water, the depth should extend well into the water bearing material. Document in design notes when springs or seepage flow is used to reduce total needs and losses. Use pipe if needed for water level or erosion control.

#### **ESTIMATING THE VOLUME OF AN EXCAVATED POND**

The following example shows how to use the tables in the design of excavated ponds (AL-ENG-6) in Figure AL11-6.

Job Class I - Usually considered Class I unless hazard downstream.

Drainage Area 2 Ac. - Watershed area draining into pond.

Soil Series Melvin - Soil into which the pond is excavated.

Cattle 30 - Number of cattle landuser expects to have on the pasture area.

Days 180 - Includes possible days in which no return flow is expected.

Cattle Needs 0.249 AF - Enter Table AL11-8 with number of cattle at 30 and water needs at 180 days, at the intersection read 0.249 ac.ft.

Losses 0.821 AF - Enter Table AL11-7 using 180 days and presized pond or acres column to find seepage and evaporation losses at 0.821 ac.ft. (If the alternative design method, Table AL11-9, is used, the losses still should be recorded on the AL-ENG-6 when the surface dimensions have been determined.

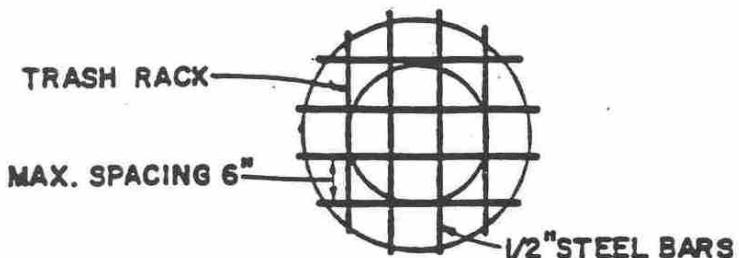
Storage Required -  $0.249 + 0.821 = 1.070$  AF. Total cattle needs, seepage and evaporation losses.

Surface Size - 100 x 100 ft. - Enter Table AL11-8 with desired end and side slopes of pond, 4:1, 3:1, and 2:1, with either the pond size 100 x 100 ft. or storage area feet 1.070 (Sheet 3 of 6) and final depth of 8 ft. with design storage of 1.138 AF, yardage of 1836 C.Y. and bottom size of 68 x 44 feet.

The remaining design parameter are in accordance with standards and specifications and land owners and designers options.

NOTE: ALTERNATE TRASH RACK OF EXPANDED METAL, HAVING OPENINGS OF  $1\frac{5}{8}$ " X  $3\frac{7}{16}$ " TO BE REMOVABLE

1/ DIAMETER OF PIPE OR BARREL



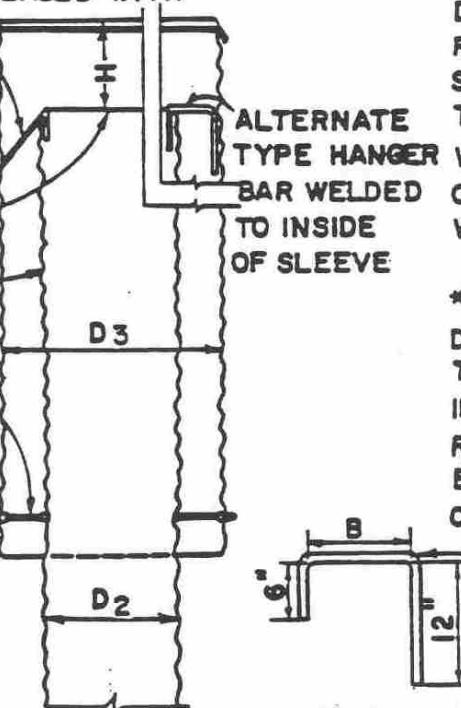
PLAN

HANGER BOLT, THREADED WITH WASHER & NUT  
USE 3 120° APART

ANY FLANGES ON THE RISER WITHIN THE SLEEVE MUST BE REMOVED

C.M. RISER  
C.M. SLEEVE D<sub>3</sub>

SPACER 1/2" ZINC PLATED CARRIAGE BOLT WITH NUTS ON INSIDE AND OUTSIDE OF SLEEVE  
USE 3 120° APART  
(OPTIONAL)

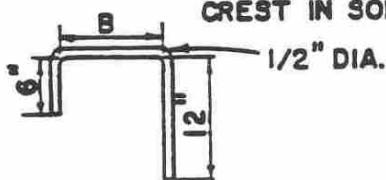


ELEVATION

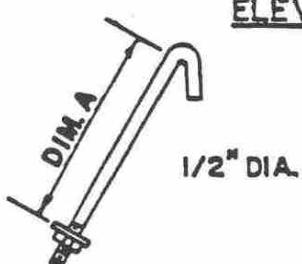
DIAMETERS (INCHES)			
D <sub>1</sub>	D <sub>2</sub>	D <sub>3</sub>	MIN. H (FT.)
4	6	10	0.5
6	8	12	0.5
8	10	15	1.0
10	12	18	1.0
12	18	24	1.0
15	21	30	1.0
18	24	36	1.5
24	30	48	1.5
30	36	54	1.5

THE ABOVE TABLE OF DIFFERENT SIZES OF RISERS AND RISER SLEEVES ARE SUCH THAT THE RISER PIPE WILL FLOW AT FULL CAPACITY FROM DEEP WATER FLOW

\* NOTE THAT THE DIMENSION H INCREASES THE MINIMUM DIFFERENCE IN ELEVATION BETWEEN RISER CREST AND EMERGENCY SPILLWAY CREST IN SOME CASES



TYPICAL SECTION  
ALTERNATE HANGER BOLT



TYPICAL SECTION  
HANGER BOLT

TRASH RACK AND DEEP WATER RELEASE FOR FARM POND RISERS

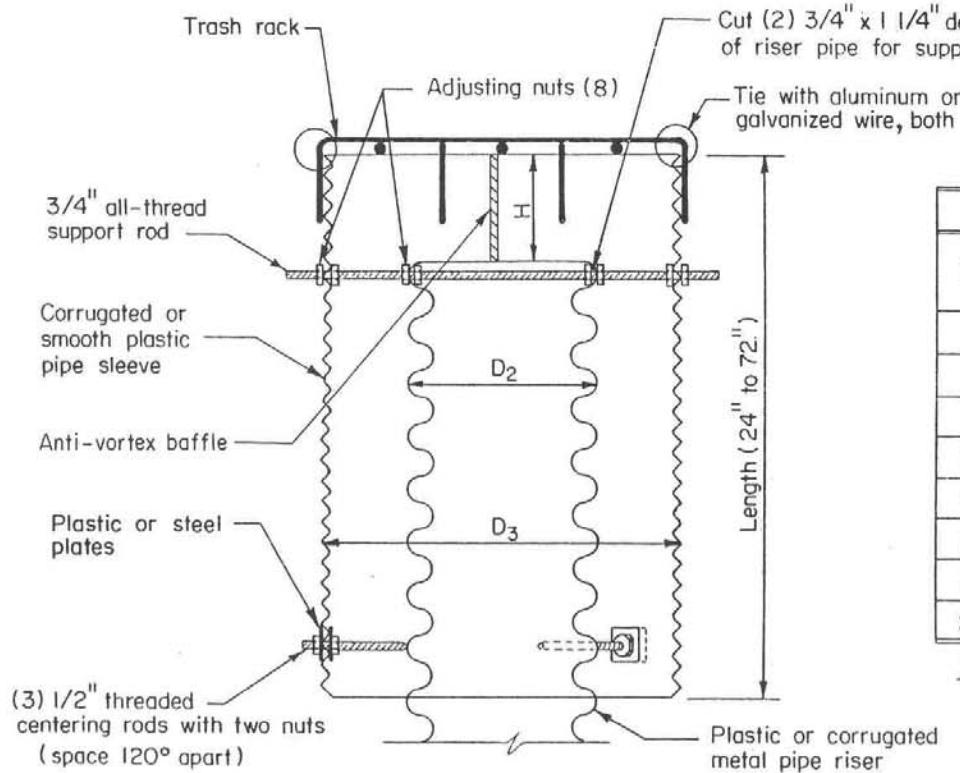
U. S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE

Drawn	Approved By
Signed	Date
Drawn	Time
Typed	Time
Checked	Sheet Drawing No.
	No. T
	of 2

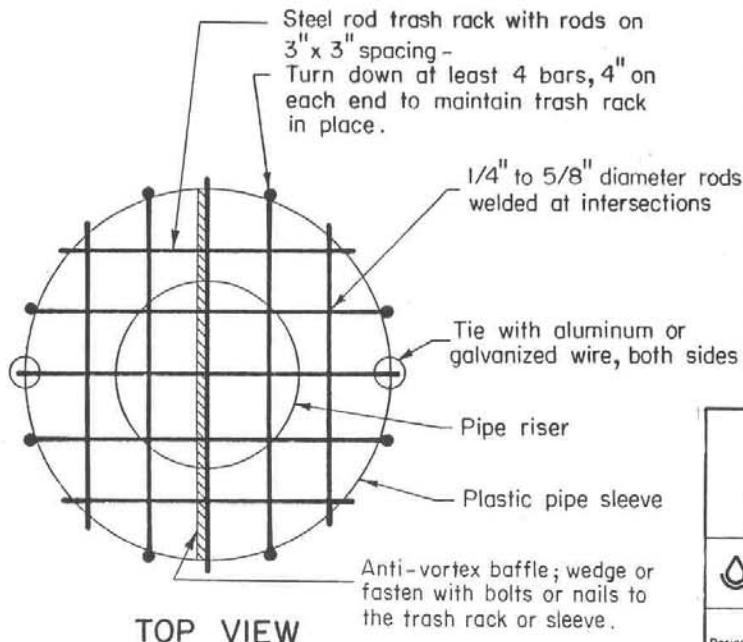
Exhibit AL11-1. Corrugated Metal or Smooth Steel Trash Rack and Deep Water Release Sleeve for Ponds.

AL11-60(1)

(210-VI-NEH, AL6, October 2008)



### SIDE VIEW



### TOP VIEW

#### NOTES:

- (1) Trash rack or sleeve for use on farm ponds.
- (2) Use above table to size trash rack or sleeve.
- (3) Minimum wall thickness of smooth plastic pipe should be 0.25".
- (4) All metal parts to be galvanized, cadmium plated or stainless steel.
- (5) All plastic riser pipes will have a support-a treated post or equivalent.
- (6) Anti-vortex baffle can be treated timber, durable plastic or metal. Fabricate the baffle to fit tight and upright by wedging or by fastening to the trash rack or sleeve.

#### PLASTIC SLEEVE AND TRASH RACK FOR FARM POND RISERS

FARM  
ALABAMA

U. S. DEPARTMENT OF AGRICULTURE  
SOIL CONSERVATION SERVICE

Designed.....	Date.....	Approved by.....
Drawn.....	Title.....	
Traced.....	Title .....	Sheet .....
Checked.....	No. 2	of 2 Drawing No.....

Exhibit AL11-2. Trash Rack and Deep Water Release for Farm Pond Risers.

AL11-60(2)

(210-VI-NEH, Amend. AL6, October 2008)



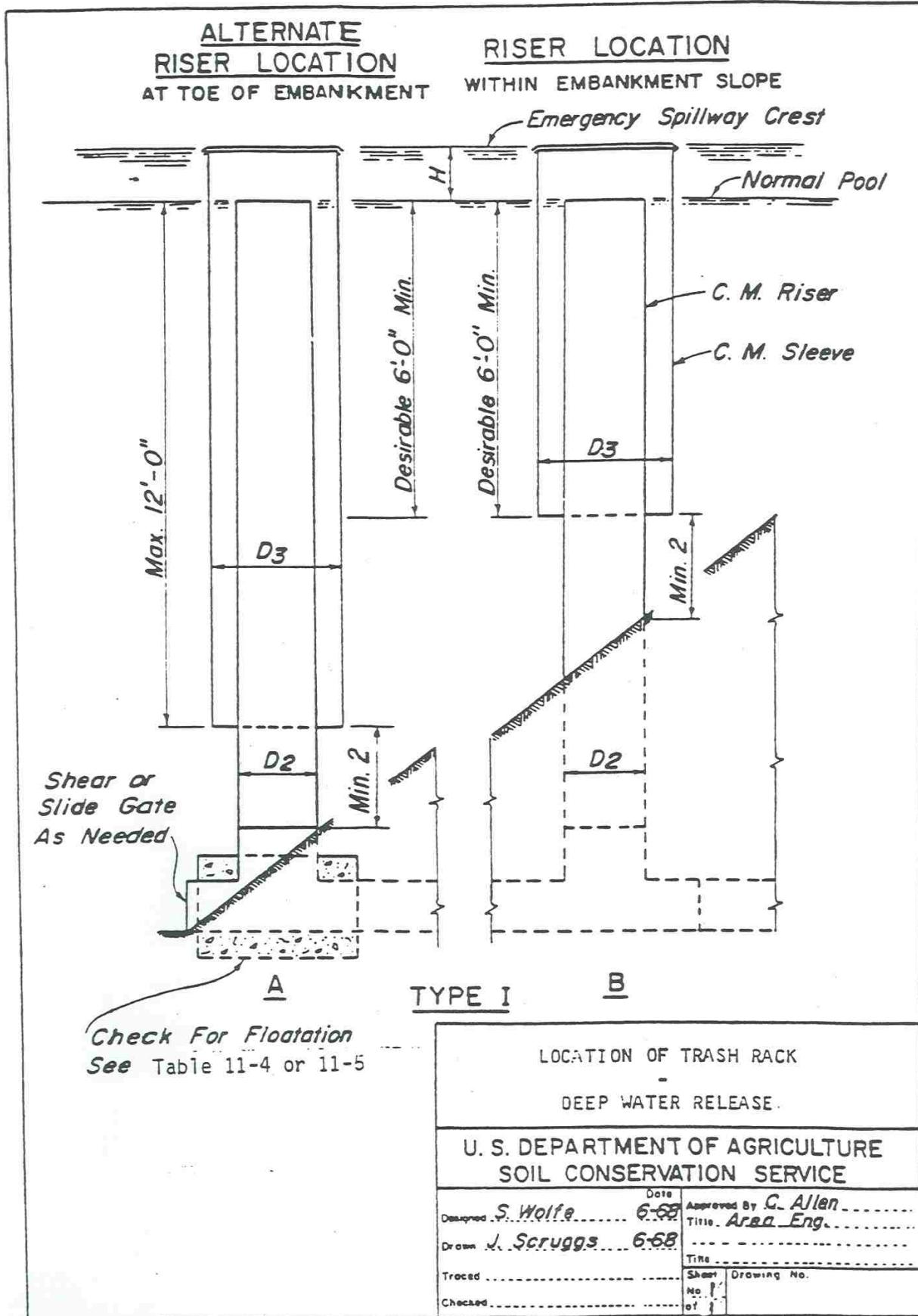


Exhibit AL11-3. Location of trash rack - Deep water release.

AL11-60(3)

(210-VI-NEH, Amend. AL6, October 2008)

		TABLE B VALUES OF Qu IN Ft <sup>3</sup> /S/acre																													
		STORAGE IN WATERSHED INCHES																													
Vr	Vs	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4	1.6	1.8	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0
1.0		.89	.39	.19	.10	.06	.044	.031	.024	.018																					
1.4		.62	.33	.20	.12	.08	.05	.04	.030	.022																					
1.8			.57	.31	.21	.14	.09	.07	.05	.038	.026																				
2.0				.57	.33	.23	.16	.11	.08	.06	.039	.028																			
2.2					.59	.37	.25	.19	.13	.09	.06	.041	.031																		
2.4						.64	.42	.27	.21	.14	.09	.06	.040																		
2.6							.62	.45	.32	.23	.13	.08	.05	.020																	
2.8								.65	.49	.34	.20	.12	.08	.05	.03																
3.0									.65	.49	.34	.20	.12	.08	.05	.03															
3.2	USE MINIMUM VALUES IN THIS AREA									.69	.41	.25	.16	.11	.08	.05															
3.4											.55	.34	.22	.15	.11	.08	.05														
3.6												.49	.31	.20	.14	.10	.08	.05													
3.8												.66	.44	.28	.19	.14	.10	.08	.05												
4.0													.56	.39	.26	.19	.14	.10	.08	.05											
4.2														.49	.34	.23	.16	.13	.10	.08	.05										
4.4														.65	.45	.31	.22	.17	.13	.09	.07	.05									
4.6															.55	.41	.28	.20	.16	.12	.09	.07	.05								
4.8															.49	.36	.25	.21	.14	.12	.09	.07	.05								
5.0																.62	.45	.33	.27	.19	.15	.12	.09	.07	.06						
5.2																	.55	.43	.33	.23	.19	.14	.11	.08	.06	.05					
5.4		DISCHARGE VALUES TO THE LEFT OF LINE ARE TO BE USED FOR INTERPOLATION ONLY HOWEVER, INTERPOLATED VALUES SHOULD NOT EXCEED 0.47 ft <sup>3</sup> /s/acre.																													
5.6																		.49	.39	.31	.23	.18	.14	.11	.09	.07	.05				
5.8																		.58	.45	.35	.28	.22	.17	.14	.11	.09	.07	.06			
6.0																			.55	.42	.34	.27	.21	.17	.14	.11	.09	.07			
6.2		PIPE FLOW STRUCTURES WITH A DISCHARGE 0.47 ft <sup>3</sup> /s/acre.																													
6.4																			.61	.49	.38	.30	.24	.20	.16	.13	.11	.09	.07		
6.6																			.59	.46	.37	.29	.27	.19	.16	.13	.11	.09			
6.8																				.55	.44	.35	.29	.24	.20	.16	.13	.11			
7.2																				.52	.42	.35	.29	.24	.20	.16	.14				
7.6																				.50	.42	.34	.28	.23	.19	.16					
																					.50	.40	.33	.27	.23	.18					
																						.59	.47	.40	.32	.27					
																							.58	.47	.38						

Exhibit AL11-4. Table "B"

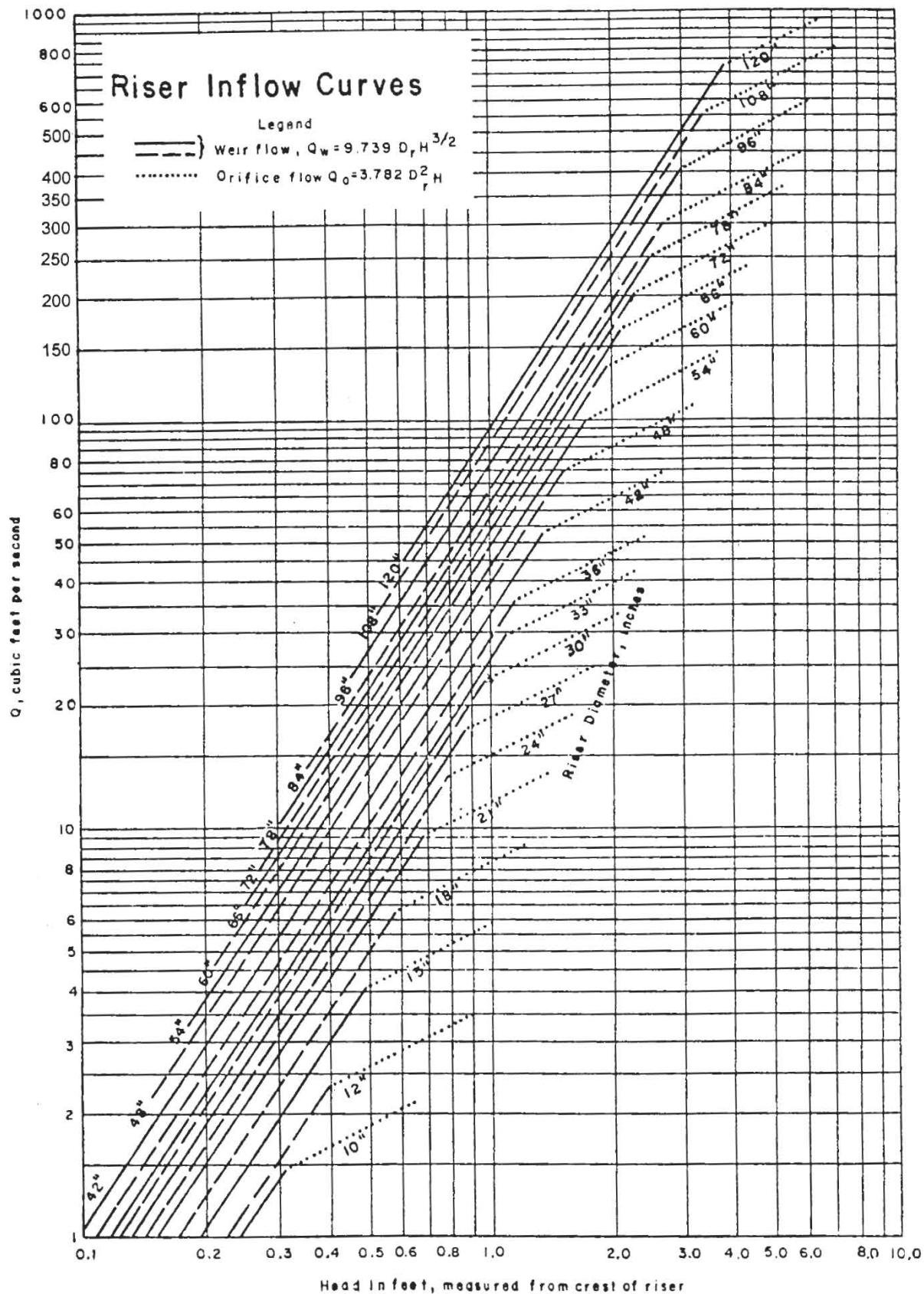


Figure AL11-1. Circular Riser Inflow Curves.

AL11-60(5)

(210-VI-NEH, Amend. AL6, October 2008)

HEAD DISCHARGE TABLE FOR CORRUGATED METAL PIPE  
DROP INLETS  
(WEIR FLOW CONDITION)

Riser Diameter Inches	Head in Feet												
	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	1.6
15	2.7	3.8	4.9	6.3									ORIFICE
18	3.2	4.5	5.9	7.6	9.3	10.9							FLOW
21	3.8	5.3	7.0	8.8	10.7	12.8	15.0						CONDITIONS
24	4.3	6.0	7.9	10.1	12.3	14.6	17.1	19.7	22.4				CONTROL
30	5.4	7.5	9.8	12.6	15.4	18.2	21.4	24.6	28.0	31.7	35.5		
36	6.4	9.0	11.8	15.1	18.5	21.8	25.7	29.5	33.6	38.0	42.6	47.2	51.9
42	7.5	10.5	13.8	17.7	21.6	25.5	30.0	34.5	39.3	44.4	49.8	55.1	60.5
48	8.6	12.0	15.7	20.2	24.6	29.1	34.2	39.4	44.8	50.7	56.8	63.0	69.1
54	9.6	13.5	17.7	22.7	27.7	32.8	38.5	44.3	50.5	57.0	64.0	70.9	77.8
60	10.7	15.0	19.7	25.2	30.8	36.4	42.8	49.2	56.1	63.3	71.0	78.7	86.4

Riser Diameter Inches	Head in Feet									
	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	
42	66.5	72.5								ORIFICE FLOW
48	76.0	82.8	89.7	96.9	104.1					CONDITIONS CONTROL
54	85.5	93.2	100.9	109.0	117.1	125.6	134.5	143.3		
60	95.0	103.6	112.1	121.1	130.1	139.5	149.3	159.2	169.0	

NOTES: (1) The discharge capacities shown in this table are based on the formula:

$$Q_2 = C_2 L H_2^{3/2}$$

$Q_2$  = discharge capacity of weir, in c.f.s.

$C_2$  = weir coefficient = 3.33

L = length of weir crest, in feet (for circular riser with headwall, L = 2.57 times diameter of riser).

$H_2$  = distance from crest of riser to water surface in reservoir, in feet.

(2) The diameter of the riser should be at least  $1\frac{1}{4}$  times the diameter of barrel.

(3) Use this table in conjunction with orifice flow and full pipe flow conditions to determine capacity of the drop inlet.

Figure AL11-2. Chart for determining inlet proportions and required head over inlet.

Siphon Pipe Flow Rates (Q) in CFS (for pipe length = 70 feet)						
<b>Head (H) in feet</b>	<b>Nominal pipe diameter, "D" in inches (Area, sq.ft.)</b>					
	4(0.09)	6(0.20)	8(0.35)	10(0.55)	12(0.79)	14*(0.99)
2	0.305	0.833	1.666	2.816	4.290	5.608
4	0.432	1.178	2.356	3.982	6.066	7.931
6	0.529	1.443	2.885	4.877	7.430	9.713
8	0.610	1.666	3.331	5.632	8.579	11.216
10	0.682	1.863	3.725	6.297	9.592	12.540
12	0.748	2.040	4.080	6.898	10.507	13.737
14	0.808	2.204	4.407	7.450	11.349	14.837
16	0.863	2.356	4.711	7.965	12.133	15.862
18	0.916	2.499	4.997	8.448	12.869	16.824
20	0.965	2.634	5.267	8.905	13.565	17.734
Length (L)						
<b>in feet</b>	<b>Correction factors for other pipe lengths.</b>					
	70	1.00	1.00	1.00	1.00	1.00
75	0.97	0.98	0.98	0.98	0.98	0.99
80	0.95	0.96	0.96	0.97	0.97	0.98
85	0.93	0.94	0.94	0.95	0.96	0.96
90	0.91	0.92	0.93	0.94	0.94	0.95
95	0.89	0.90	0.91	0.92	0.93	0.94
100	0.87	0.88	0.90	0.91	0.92	0.93
105	0.85	0.87	0.88	0.90	0.91	0.92
110	0.83	0.85	0.87	0.88	0.90	0.91
115	0.82	0.84	0.86	0.87	0.88	0.89
120	0.80	0.83	0.84	0.86	0.87	0.88
125	0.79	0.81	0.83	0.85	0.86	0.87
130	0.78	0.80	0.82	0.84	0.85	0.86
135	0.76	0.79	0.81	0.83	0.84	0.86
140	0.75	0.78	0.80	0.82	0.84	0.85
145	0.74	0.77	0.79	0.81	0.83	0.84
150	0.73	0.76	0.78	0.80	0.82	0.83
160	0.71	0.74	0.76	0.78	0.80	0.81
* The actual diameters used in calculating flow rates for these two pipe sizes are 13.5 inches and 15.5 inches, respectively.						
<b>Assume full pipe flow when pool rises to D/3 above crest of siphon.</b>						
<i>The design data for Q is based on the following parameters:</i>						
$Q=8.025(A)(H)^{0.5}/(1+Km+KpL)^{0.5}$ Km=Ke+sum Kb's=2.45						
Ke=1 n=0.012 (PVC or smooth steel) Kp = 5087n^2/D^1.331						
Example: For H=16' and D=8", to adjust Q for L=120', find factor of 0.84. $Q = (4.711)(0.84)/=3.96 \text{ cfs}$						

Figure AL11-3. Siphon Pipe Flow Rates.



PONDSA. Engineering Surveys for Design and Construction Layout (SCS-ENG-28 and 29 - Loose Leaf)

1. Complete title page (SCS-ENG-28) with sketch of practice location.
2. Show at beginning of survey: farmer's name, purpose of survey, name of practice, party members, duties, and date.
3. Describe benchmark.
4. Close out survey within allowable limits.
5. Soil borings.
6. Complete design date including placement of spoil and vegetative needs.
7. Include in surveys: cross section, pipe elevations, waterline, and stakes for construction.
8. Design approval and date.
9. Review General Manual 450-407 for all components.

B. Construction and Performance Check (SCS-ENG-29 - Loose Leaf)

1. Use Pond Construction Check Data Form.
2. Make profile along centerline of top of completed dam.
3. Cross-section at one or more locations of the completed dam.
4. Profile and cross section of completed spillway.
5. Elevation of completed riser and invert of barrel at outlet end of pipe spillway.
6. Statement of depth and area of normal pool if part of specifications.
7. Other items as specified by General Manual 450-407.
8. General remarks and certification that practice meets construction plans and specifications.

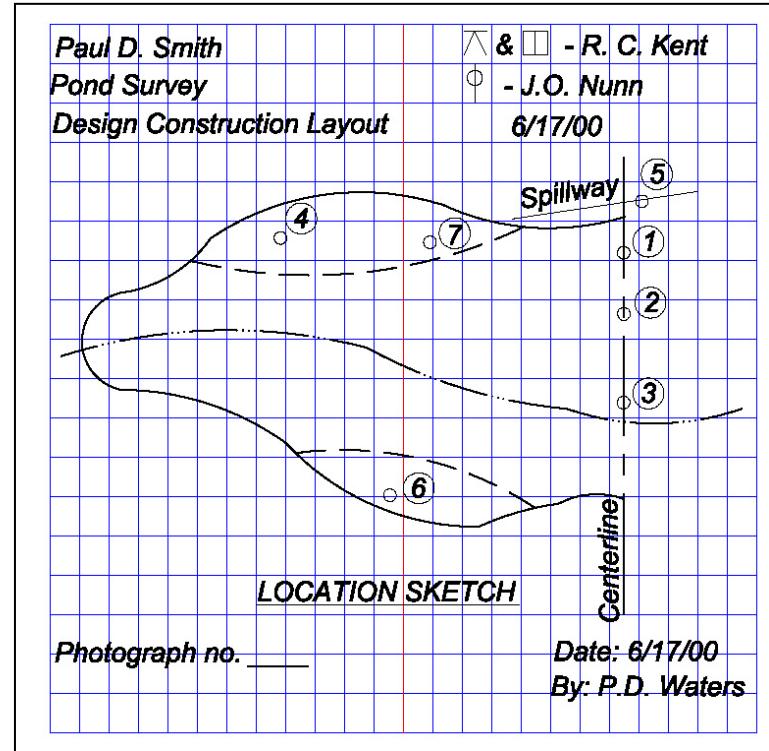
SCD	Lee County	Date	6/17/00
Field Office	Opelika		
Name	Paul D. Smith		
<input checked="" type="radio"/> Individual	<input type="radio"/> Group	<input type="radio"/> Unit of Gov't.	
(circle one)			
Job	Earthfill Pond		
Design Survey	6/17/00	Const. Layout	6/17/00
Constr. Check	7/18/00	Other	
Ident. No.	1171	Field No.	4
ACP No. C-72			
<p>Scale: 1" = <u>2,640'</u></p>			
<p>Legal Description: <u>SW 1/4 of NW 1/4 of Sec 22 T 20 N R 26 E</u></p> <p>or</p> <p>Location: <u>1/2 mile S. of Oak Bowery Church</u></p>			

SCS-ENG-28 REV. 5-75

Figure AL11-4. Design and construction layout survey notes for earth fill pond.

(Sheet 1 of 4)

U. S. Dept. of Agriculture Natural Resources Conservation Service		AL-ENG-4A July 2007
POND DESIGN DATA		
Computer Design Manual Design X		
Job Class <b>IV</b>	Soils <b>Eutaw</b>	Hydro. Gr. <b>D</b>
Land Use <b>Pasture</b>	Trtmt. <b>NMT</b>	Condition <b>Fair</b>
Rainfall Dist. Type II or III	DA <b>230</b> ac.	CN <b>84</b>
W/S Slope <b>3</b> %	Flow Length <b>4800</b> ft.	Tc <b>0.94</b> hrs.
Rainfall (ps) <b>6.5</b> in.	Ia <b>10</b> yr.;	Ia <b>0.381</b> in.
Ia/P(ps) = <b>0.06</b>	Qpeak(ps) = <b>0.48</b> cfs/ac/in;	Vr = <b>4.7</b> in.
Qi(ps) = [Qpeak(ps)] <b>0.48</b> x (DA) <b>230</b> x (Vr) <b>4.7</b> = <b>518</b> cfs		
Vs = [( <b>25</b> ac. + <b>29</b> ac.) / 2] x <b>2.0</b> ft. = <b>54</b> AF		
Vs (in.) = [(Vs) <b>54</b> AF x 12] / (DA) <b>230</b> ac. = <b>2.8</b> in.		
Use Vs = <b>2.8</b> in. & Vr = <b>4.7</b> in.		
See National Engineering Field Handbook, Chapter 11, Exhibit 11-4.		
(TAB A) Qo(ps) = _____ x _____ cfs = _____ cfs		
(TAB B) Qo(ps) = <b>0.30</b> x <b>230</b> ac. = <b>69</b> cfs		
H = <b>15</b> ft.; Pipe Size = <b>30</b> in. barrel; <b>48</b> in. riser		
Rainfall (es) <b>8.7</b> in. <b>50</b> yr.		
Ia/P(es) = <b>0.04</b> ; Qpeak(es) = <b>0.48</b> cfs/ac/in; R.O. (es) = <b>6.8</b> in.		
Qes = [Qpeak(es)] <b>0.48</b> x (DA) <b>230</b> x [R.O.(es)] <b>6.8</b> = <b>750</b> cfs		
Qes(design) = (Qes) <b>750</b> - [Qi(ps)] <b>518</b> = <b>232</b> cfs		
Erosion Resistant Soil: Yes	No	Cover <b>Fescue</b>
Cond. Stand <b>Fair</b> ; Height <b>6</b> in. to <b>10</b> in.; Slope <b>4</b> %		
Vel. <b>7</b> fps; Retardance: Stab. <b>D</b> Capacity <b>D</b>		
Control-Section Length = <b>100</b> ft.; q/ft. = <b>4</b>		
S/W BW = [Qes(design)] <b>232</b> / (q/ft.) <b>4</b> = <b>58</b> ft.		
Use: BW = <b>2 x 30</b> ft.; Hp = <b>1.7</b> ft.; S/W SS = <b>3</b> : 1		
Exit Slope Range: <b>1</b> to <b>7</b> Adequate <b>YES</b>		
Embankment SS = <b>3</b> : 1 TW = <b>14</b> ft.		
Freeboard = <b>1.5</b> ft. El Riser <b>98.0</b> El Aux. S/W <b>100.0</b>		
El Top of Dam <b>103.2</b> Settlement <b>3</b> % Pond Use <b>Catfish</b>		
Capacity = <b>0.4</b> x <b>25</b> ac. x <b>13</b> ft. = <b>130</b> AF		
Barrel <b>149</b> ft. of <b>30</b> in. <b>Smooth Steel</b> Pipe		
Riser <b>13</b> ft. of <b>48</b> in. <b>Smooth Steel</b> Pipe		
Valve <b>30</b> in.; <b>3</b> Collars(ASC) <b>1/4</b> in. x <b>5</b> ft. x <b>5</b> ft.		
<b>Trash Rack</b> Sleeve <b>60</b> in. x <b>4</b> ft.		
Flotation(ballast) = [(B) <b>783.7</b> - (W) <b>117.8</b> ] x (H) <b>13</b> / 87.6 = <b>99</b> CF		
Concrete = [(ballast) <b>99</b> CF + (ASC) <b>—</b> CF] / 27 = <b>3.7</b> CY		
Quantity of Fill <b>25,000</b> CY Veg. <b>2.5</b> ac.		
Design By <b>REK</b>	Checked By <b>ERJ</b>	



LOCATION SKETCH DATE **1-00**  
BY **JLD**

- PHOTOGRAPH NO. **R-22**

SOIL BORINGS

HOLES	1	2	3	4	5	6	7
DEPTH							
1	SM	SM	SM	SM	SM		
2	SC	SC	SM	SM	SP		
3	SC	SC	SC	SC	SM		
4	SC	SC	SC	SC	SC		

REMARKS: Material is good for pond site. Salvage topsoil for reuse.

U.S. Dept. of Agriculture  
Natural Resources Conservation Service

AL-ENG-17  
Rev. 9/99

Figure AL11-4. Design and Construction layout survey notes for earth fill pond.

Station	B. S.	H. I.	F. S.	Elev.	Elev. Top of Dam
TBM	5.10	106.10		101.00	(Constructed)
0+00			+6.1	100.00	100.00
0+25			+6.1	100.00	100.10
0+50			+6.1	100.00	100.20
0+75			+6.1	100.00	100.30
TP	1.70	96.60	11.20	94.90	
1+00			-3.4	100.00	100.40
1+25	Pipe location		-3.4	100.00	100.70
1+50			-3.4	100.00	100.70
1+75			-3.4	100.00	100.70
2+00			-3.4	100.00	100.50
2+25			-3.4	100.00	100.30
TP <sub>2</sub>	11.00	106.40	1.20	95.40	
2+50	End fill		+6.4	100.00	
2+57	Edge spillway		+9.0	97.4	

<i>Designed by: J. Scruggs</i>		<i>Checked by: W. O. 6/17/00</i>	
<i>Nail in west side of 8" Sweetgum, 100' west of sta. 0+00.</i>			
Sta. 0+00			
Fill Vol.	<u>6.1</u> <u>0.00'</u>	<u>6.1</u> <u>F=0.0-6.0'</u>	<u>6.1</u> <u>F=0.0-6.0'</u>
0.62		<u>7.2</u> <u>F=1.1'</u>	
1.71		<u>8.5</u> <u>F=2.4'</u>	
6.67	<u>11.9</u> <u>F=5.8-23.4'</u>	<u>12.1</u> <u>F=6.0'</u>	<u>12.5</u> <u>F=6.4-25.2'</u>
11.57		<u>5.0</u> <u>F=8.4'</u>	
30.54	<u>11.0</u> <u>F=14.4-49.2'</u>	<u>11.3</u> <u>F=14.7'</u>	<u>11.4</u> <u>F=14.8-50.4'</u>
30.54		<u>11.3</u> <u>F=14.7'</u>	
29.81	<u>11.0</u> <u>F=14.4-49.2'</u>	<u>11.1</u> <u>F=14.5'</u>	<u>11.2</u> <u>F=14.6-49.8'</u>
16.92		<u>7.1</u> <u>F=10.5'</u>	
6.14		<u>2.3</u> <u>F=5.7'</u>	
0.49	<u>7.3</u> <u>F=0.9-8.7'</u>	<u>7.3</u> <u>F=0.9'</u>	<u>7.3</u> <u>F=0.9-8.7'</u>
		<u>6.6</u> <u>C=2.4'</u>	

Figure AL11-4. Design and construction layout survey notes for earth fill ponds.

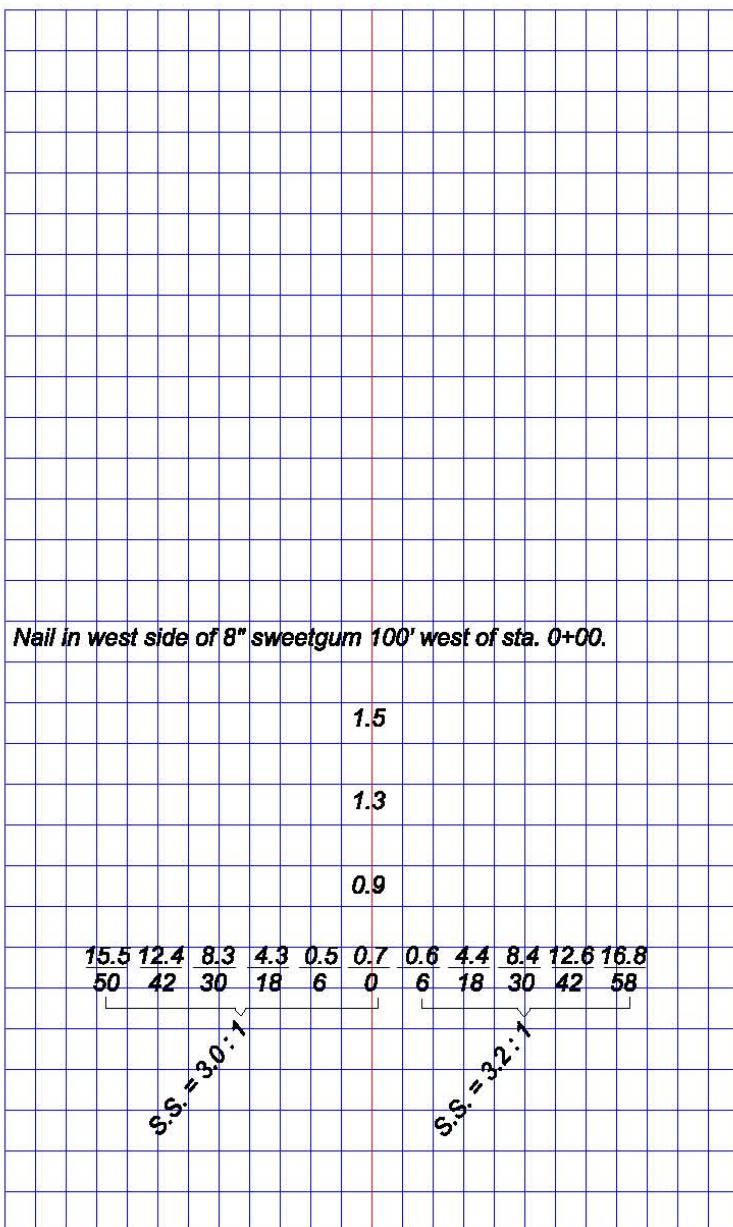






7/10/00	Approved cut-off for backfill.	J.O.N.	
7/12/00	Completed laying pipe and marked riser for waterline elevation.	J.O.N.	
7/18/00	Checked out pond. Construction O.K. Talked with farmer about seeding fescue and clover and mulching dam and spillway. Also recommended temporary fencing to exclude livestock.	J.O.N.	
7/30/00	Dam, spillway and borrow area seeded and mulched; dam and spillway fenced.	J.O.N.	
T.B.M.	0.52	101.52	101.00
0+00		+1.5	100.00
0+50		+1.4	100.10
1+00		+1.1	100.40
1+25		+0.8	100.70

Figure AL11-5. Construction check survey notes for earth fill pond.



(Sheet 1 of 3)



Station	B. S.	H. I.	F. S. or grade rod	Elev. or planned elev.
		<b>101.52</b>		
<i>Crest of riser</i>		+5.32		96.20
<i>Invert outlet pipe</i>		16.5		85.0
<b>1+75</b>		+0.8		100.70
<b>2+25</b>		+1.2		100.30
<b>2+58</b>	<i>Edge spillway</i>	+4.1		97.40
<b>2+80</b>	<i>CL spillway</i>	+4.1		97.40
<b>3+02</b>	<i>Edge spillway</i>	+4.1		97.40
<b>TP</b>	<b>4.18</b>	<b>103.24</b>	<b>2.46</b>	<b>99.06</b>
<b>3+22</b>		+0.9		102.30
 <i>Profile spillway</i>				
 <b>0+00</b>		+7.0		96.20
 <b>0+50</b>	<i>Begin level section</i>	+5.8		97.40
 <b>0+80</b>	<i>Control section</i>	+5.0		97.40

Figure AL11-5. Construction check survey notes for earth fill pond.

<i>Paul D. Smith</i>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<b>J.O. None</b>
<i>Pond Construction Check Survey</i>			<input type="checkbox"/> <b>R.C. Kent</b>
			<b>7-18-00</b>
		<b>5.3</b>	
		<b>0.7</b>	
		<b>1.0</b>	
		<b>4.1</b>	
		<b>4.1</b>	
		<b>4.1</b>	
		<b>0.8</b>	
		<b>7.0</b>	
		<b>5.8</b>	
		<b>5.8</b>	







## EXCAVATED PONDS

(210-VI-NEH, Amend. AL6, October 2008)

AL11-60(15)

- A. Engineering Surveys for Design and Construction Layout  
(SCS-ENG-28 and 29 - Loose Leaf Notes)
  - 1. Complete title page with sketch of practice location.
  - 2. Show at beginning of survey; farmer's name, purpose of survey, name of practice, party members, duties, and date.
  - 3. Describe benchmark.
  - 4. Close out survey within allowable limits.
  - 5. Soil borings.
  - 6. Complete design data including placement of spoil and vegetative needs.
  - 7. Include in surveys; cross sections, bottom elevation, and stake for construction.
  - 8. Design approved and checked.
  
- B. Construction and Performance Check  
(SCS-ENG-29 - Loose Leaf Notes)
  - 1. Survey cross sections showing side slopes, depth with measurements of length and width of pond.
  - 2. When spoil is placed in a dam, show differential elevations between by-pass and top of dam.
  - 3. Supporting statements.
    - a. Placement and disposal of spoil.
    - b. Condition of clearing disposal.
    - c. Condition of vegetation.
    - d. General remarks about construction meeting plans and specifications along with signature, title, and dates.

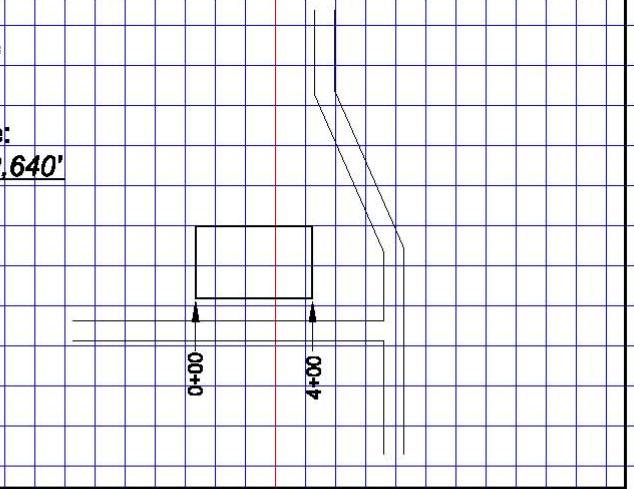
U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE	
SCD	<i>Cherokee County</i>
Field Office	<i>Centre</i>
Name	<i>John Jones</i>
<input checked="" type="checkbox"/> Individual <input type="checkbox"/> Group <input type="checkbox"/> Unit of Gov't. (circle one)	
Job	<i>DO Pond</i>
Design Survey	<i>3/20/91</i>
Constr. Check	<i>3/30/91</i>
Ident. No.	<i>ACP-C-72</i>
Date	<i>3/20/00</i>
Const. Layout	<i>3/20/00</i>
Other	
Field No.	<i>4</i>
 <b>Scale:</b> $1'' = 2,640'$  	
<b>Legal Description:</b> $SE \frac{1}{4}$ of NW $\frac{1}{4}$ of _____ Sec 25 T 10 S R 11 E or <b>Location:</b> <i>3 miles west of Beltsville</i>	

Figure AL11-6. Design - Construction layout survey notes for excavated pond.



U.S. DEPT. OF AGRICULTURE Natural Resources Conservation Service		AL-ENG-6 Rev. 9/99
DUG POND DESIGN DATA		
IF STANDARDIZED DESIGN, CHECK HERE		
JOB CLASS <u>I</u>	DRAINAGE AREA <u>2</u> AC.	
SOIL SERIES <u>Melvin</u>		
CATTLE <u>30</u>	HEAD <u>180</u>	DAYS OR <u>6</u> MONTHS
CATTLE NEEDS = <u>0.249</u> AF. LOSSES = <u>0.821</u> AF.		
STORAGE REQ'D = <u>0.249</u> + <u>0.821</u> = <u>1.070</u> AF.		
SURFACE SIZE = <u>100</u> x <u>100</u> FT. S. SLOPES <u>2</u> : <u>1</u>		
END SLOPES <u>4</u> : <u>1</u> & <u>3</u> : <u>1</u> DEPTH <u>8</u> FT.		
DESIGNED STORAGE = <u>1.138</u> AF.		
YARDAGE = <u>1836</u> BOT. SIZE = <u>44</u> x <u>68</u> FT.		
SPOIL IS TO BE <u>shaped on 3 sides</u>		
SEEDED TO <u>fescue/clover with mulch</u>		
DESIGNED BY <u>J.R.S.</u>	CHECKED BY <u>R.G.H.</u>	

<u>LOCATION SKETCH</u>							
• PHOTOGRAPH NO. <u>R-22</u>				DATE <u>1-00</u> BY <u>JLD</u>			
SOIL BORINGS							
HOLES	1	2	3	4	5	6	7
DEPTH							
1	SM	SM	SM	SM	SM		
2	SC	SC	SM	SM	SP		
3	SC	SC	SC	SC	SM		
4	SC	SC	SC	SC	SC		
REMARKS: The site should hold water and is fed by a small underground seep flow.							
U.S. Dept. of Agriculture Natural Resources Conservation Service				AL-ENG-17 Rev. 9/99			

NOTE:  
Elev. Ground = 99.82  
Depth = 8.0  
Bot. Pond = 91.8  
Spoil Placement  
El. nor. grnd. = 99.82  
+Spoil Height = 3.0  
El. Top Spoil = 102.82

Station	B. S.	H. I.	F. S.	Elev.	Plan. Elev.	John Jones - Dug Pond	Design - Construction Layout						J.R. Smith
TBM	4.12	104.12		100.00									R.G. Hunt
0+00			+12.3		91.8		4.3	4.4	4.5	4.3	4.3	4.0	3/20/00
						c = 8.0	0	20	40	60	80	100	c = 8.3
Ave. Rod			+4.3	99.82			4.0	4.2	4.4	4.3	4.3	4.0	
1+00			+12.3		91.8	Bat. pond	0	20	40	60	80	100	c = 8.3
Top Spoil			+1.3	102.8									
TBM			4.12	100.00									
			-100.00	O.K.									
			0.00	J. Smith									

Figure AL11-6. Design - construction layout survey notes for excavated pond.



Station	B. S.	H. I.	F. S. or Grade Rod	Elev. or Planned Elev.
TBM	4.09	104.09		100.00
Overflow			+4.3	99.8
0+20	WL		+4.3	99.8
0+75	Bottom		+12.3	91.8
1+25	WL		+4.3	99.8
TBM		4.09	100.00	
			100.00	O.K.
			0.00	J.S.

(210-VI-NEH, Amend. AL6, October 2008)

AL11-60(17)

Figure AL11-6. Design - Construction layout survey notes for excavated pond.

John Jones - DO Pond	J.C. Smith	X	□
Construction Check	R.C. Hunt	Φ	Φ
Description p.29	12/12/77		
	4.5*		
	4.0/0		
	4.5/20		
	7.0/30	4.1:1	
	9.0/40		
	12.3/52		
	2.2:1	2:1	
3.9/0	2.8/10	2.4/20	4.5/30 12.5/48 12.4/114 8.6/122 4.5/130 4.0/146
			12.4/98
			8.0/108
			4.5/125 3.4:1
			2.2/140
			2.2/158
			6.0/180
Clearing and disposal is satisfactory, spoil is spread, shaped and seeded to fescue and clover. Construction meets plans and specs.			
J.R. Smith 2/16/77			
* Take adequate rod readings to show exact shape of pond and spoil. This must include a shot on the exact waterline, as determined from the constructed overflow, on each of the sides.			

Smooth Pipe (inches)										Corrugated Pipe (inches)									
Barrel Diam.	4	6	8	10	12	15	18	24	30	6	8	10	12	15	18	24	30		
Riser Diam.	6	*Use Figure AL11-8A								8	10	* Use Figure AL11-8a							
Head in Feet	6	0.8	1.8	3.4	5.7	8.3	14.1	24.6	40.7	65.0	1.0	2.1	3.7	5.7	10.2	15.7	31.4	53.0	
	7	0.8	1.8	3.6	5.9	8.6	14.9	24.9	42.8	69.1	1.0	2.1	3.8	5.8	10.5	16.3	32.6	55.2	
8	0.9	1.8	3.7	6.1	8.9	15.3	25.3	45.0	73.2	1.1	2.2	3.9	5.9	10.7	16.9	33.8	57.5		
9	0.9	1.8	3.8	6.4	9.2	15.8	25.7	46.9	76.5	1.1	2.2	4.0	6.1	11.0	17.3	34.8	59.3		
10	1.0	1.9	3.9	6.6	9.6	16.4	26.1	48.7	79.7	1.1	2.3	4.1	6.2	11.3	17.7	35.8	61.1		
11	1.0	1.9	4.0	6.8	9.9	17.0	26.6	50.3	82.6	1.1	2.3	4.1	6.4	11.6	18.1	36.7	62.7		
12	1.1	2.0	4.1	7.0	10.2	17.6	27.0	52.0	85.1	1.1	2.4	4.2	6.5	11.8	18.5	37.5	64.2		
13	1.1	2.0	4.2	7.2	10.5	18.1	27.2	53.3	87.4	1.2	2.4	4.3	6.6	12.0	18.7	38.1	65.4		
14	1.2	2.1	4.3	7.5	10.8	18.7	27.5	54.6	89.7	1.2	2.5	4.4	6.8	12.3	19.0	38.7	66.5		
15	1.2	2.1	4.4	7.7	11.2	19.3	27.6	57.0	93.8	1.2	2.5	4.5	6.9	12.6	19.7	40.1	69.2		
16	1.3	2.2	4.5	7.9	11.5	19.9	27.8	59.4	97.9	1.2	2.6	4.6	7.0	12.9	20.4	41.6	71.9		
17	1.3	2.2	4.7	8.1	11.8	20.5	28.1	60.9	100.4	1.3	2.6	4.7	7.1	13.2	20.6	42.3	73.2		
18	1.4	2.3	4.8	8.3	12.1	21.0	28.4	62.4	103.0	1.3	2.7	4.8	7.3	13.4	20.9	43.0	74.5		
19	1.4	2.3	4.9	8.6	12.4	21.6	28.7	63.6	105.1	1.3	2.7	4.9	7.5	13.7	21.1	43.6	75.0		
20	1.5	2.4	5.0	8.8	12.7	22.2	29.0	64.8	107.1	1.4	2.8	4.9	7.6	13.9	21.4	44.2	75.6		

\* Select riser using procedure outlined in Chapter 6 or Figure AL11-8a.

$$T \text{ (Time)} = 12.1 \times \frac{Vs}{Q_0}$$

Table AL11-2. Discharge in cubic feet per second (CFS) for pipe conduit with different heads.

**TABLE OF WEIGHTS AND BUOYANT FORCES FOR CORRUGATED METAL, STEEL, AND PLASTIC PIPE**  
Based on U.S. Standard Gages for Sheet and Plate Iron and Steel

Nominal Dia. In inches	WEIGHT (W) - POUNDS PER LINEAR FOOT <sup>1/</sup>							Buoyant Force (B) in lbs. per lin.ft.	
	CORRUGATED METAL				SMOOTH STEEL		PVC		
	GAGE				Wall Thickness <sup>2/</sup>		SDR-26 Sch. -40		
	16	14	12	10	1/8 "	1/4 "	1/2 "	SDR-26 Sch. -80	
6	4.0				8.8	14.7	32.8	2.4	12.3
8	7.3/2.3*				11.7	19.6	43.4	3.7	21.8
10	9.0/2.8				14.7	24.5	54.7	5.8	34.0
12	10.5/3.3	12.0/4.1			17.7	29.4	65.6	8.0	49.0
15	12.9/4.1	15.0/5.1			22.1	36.8	82.1	11.2	76.6
18	15.3/4.8	18.0/6.0	24.0/8.4		26.5	44.2	98.5	16.0	110.3
21	17.7/5.6	21.0/7.0	29.0/9.7		30.9	51.5	114.9	21.2	150.1
24	20.0/6.2	25.2/8.0	33.0/11.2		35.3	58.9	131.3	28.5	196.1
30		30.9/9.8	41.0/13.7		44.2	73.6	164.1	43.7	306.3
36			51.0/16.4	62.0/21.1	53.0	88.4	197.0	64.5	441.1
42			59.5/19.2	72.0/24.7	61.8	103.1	229.8	87.2	600.4
48			65.0/22.4	82.0/28.8	70.7	117.8	262.6	110.4	783.7

\* Corrugated galvanized steel/corrugated aluminum (pounds per linear foot)

<sup>1/</sup> Use these values when weight is not available from manufacturer.

<sup>2/</sup> For steel pipe wall thickness of 3/16" and 3/8", interpolate weight/foot from table.

Check for riser flotation:

Given: Corrugated steel pipe riser  
Diameter = 18 in., 16 gage  
h = Height = 15 feet  
No fill over outlet pipe

62.4 lb/cu.ft. = unit weight of water

150.0 lb/cu.ft. = unit weight of concrete

From table: W = Weight = 15.3 pounds/linear foot  
B = Buoyancy = 110.3 pounds/linear foot

Required volume of concrete: (At riser base)

$$\frac{(B-W)h}{87.6} = \frac{(110.3 - 15.3)15}{87.6} = 16.3 \text{ cu.ft.}$$

NOTES:

- (1) Weight of submerged concrete = 150 lb/cu.ft.  
-62.4 lb/cu.ft. = 87.6 lb/cu.ft. Factor  
of safety - 1.0. Therefore,  $87.6 / 1.0 = 87.6 \text{ lb./cu.ft.}$
- (2) Factor of safety of 1.0 was used due to  
weight of trash rack or sleeve and bending  
force as the result of barrel being imbedded  
in the dam. Riser placed in the dam with 5 feet  
of fill over outlet pipe requires no check of  
buoyant forces.

Buoyant Forces for Metal and Plastic Pipe			
U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE			
Designed A.W. Underwood	7/87	Approved by	
Drawn A.W. Underwood	7/87	Title	
Traced J.L. Dowdy	7/87	Title	
Checked J.L. Spooner	7/87	Sheet No	Drawing No
		of	

Table AL11-3. Weights and Buoyant Forces for Corrugated Metal, Steel, and Plastic Pipe.



Riser Base Size	MAXIMUM RISER HEIGHT (FT.)					
	Riser Diameter (inches)					
	42	36	30	24	21	18
3' x 3' x 2'				6.0	7.9	11.1
3 1/2 ' x 3 1/2 ' x 2'			5.2	8.1	10.8	15.1
3' x 3' x 3'			5.7	9.0	11.9	
4' x 4' x 2'			6.8	10.6	14.1	
3' x 3' x 4'		5.2	7.6	12.0	15.9	
3 1/2 ' x 3 1/2 ' x 3'		5.3	7.8	12.2	16.2	
4' x 4' x 3'	5.0	6.9	10.2	16.0		
3 1/2 ' x 3 1/2 ' x 4'	5.1	7.1	10.3	16.3		
4' x 4' x 4'	6.7	9.3	13.6			
5' x 5' x 4'	10.4	14.5				
5' x 5' x 5'	13.1					

NOTE: Riser Diameters Less than 18 in. Use Minimum Size Riser Base 3' x 3' x 2'.

Resource Engineer may approve smaller riser bases for riser diameter less than 18 in. according to actual on-site conditions and buoyance calculations.

Maximum Allowable Riser Height Without Supports	
U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE	
Designed _____	Date _____
Drawn _____	Approved by _____ Title _____
Traced _____	Title _____ Sheet _____ Drawing No. _____ No. _____ of _____
Checked _____	

Table AL11-4. Minimum Riser Base Size to Prevent Flotation.



FILL HEIGHT	SIDE SLOPES 2 $\frac{1}{2}$ : 1 AND 2 $\frac{1}{2}$ : 1			
	TOP WIDTH (feet)			
	8	10	12	14
0.1	0.03	0.04	0.05	0.05
0.2	0.06	0.08	0.09	0.11
0.3	0.09	0.12	0.14	0.16
0.4	0.13	0.16	0.19	0.22
0.5	0.17	0.21	0.25	0.28
0.6	0.21	0.26	0.30	0.34
0.7	0.25	0.30	0.36	0.41
0.8	0.30	0.36	0.41	0.47
0.9	0.35	0.41	0.47	0.54
1.0	0.39	0.46	0.54	0.61
1.1	0.44	0.52	0.60	0.68
1.2	0.49	0.58	0.67	0.76
1.3	0.54	0.64	0.73	0.83
1.4	0.60	0.70	0.80	0.91
1.5	0.66	0.76	0.87	0.99
1.6	0.71	0.83	0.95	1.07
1.7	0.77	0.90	1.02	1.15
1.8	0.83	0.97	1.10	1.23
1.9	0.90	1.04	1.18	1.32
2.0	0.96	1.11	1.26	1.41
2.1	1.03	1.19	1.34	1.50
2.2	1.10	1.26	1.43	1.59
2.3	1.17	1.34	1.51	1.68
2.4	1.24	1.42	1.60	1.78
2.5	1.32	1.50	1.69	1.87
2.6	1.40	1.59	1.78	1.97
2.7	1.48	1.67	1.87	2.07
2.8	1.56	1.76	1.97	2.18
2.9	1.64	1.85	2.07	2.28
3.0	1.72	1.94	2.17	2.39
3.1	1.81	2.04	2.27	2.50
3.2	1.90	2.13	2.37	2.61
3.3	1.99	2.23	2.47	2.72
3.4	2.08	2.33	2.58	2.83
3.5	2.17	2.43	2.69	2.95
3.6	2.27	2.53	2.80	3.07
3.7	2.36	2.64	2.91	3.19
3.8	2.46	2.74	3.03	3.31
3.9	2.56	2.85	3.14	3.43
4.0	2.67	2.96	3.26	3.56
4.1	2.78	3.07	3.38	3.68
4.2	2.88	3.19	3.50	3.81
4.3	2.99	3.30	3.62	3.94
4.4	3.10	3.42	3.75	4.07
4.5	3.21	3.54	3.87	4.21
4.6	3.32	3.66	4.00	4.34
4.7	3.44	3.79	4.13	4.48
4.8	3.56	3.91	4.27	4.62
4.9	3.68	4.04	4.40	4.76
5.0	3.80	4.17	4.54	4.91

FILL HEIGHT	SIDE SLOPES 2 $\frac{1}{2}$ : 1 AND 2 $\frac{1}{2}$ : 1			
	TOP WIDTH (feet)			
	8	10	12	14
5.1	3.92	4.30	4.67	5.05
5.2	4.04	4.43	4.81	5.20
5.3	4.17	4.56	4.96	5.35
5.4	4.30	4.70	5.10	5.50
5.5	4.43	4.84	5.25	5.65
5.6	4.56	4.98	5.39	5.81
5.7	4.69	5.12	5.54	5.96
5.8	4.83	5.26	5.69	6.12
5.9	4.97	5.41	5.85	6.28
6.0	5.11	5.56	6.00	6.44
6.1	5.25	5.70	6.16	6.61
6.2	5.40	5.86	6.31	6.77
6.3	5.54	6.01	6.47	6.94
6.4	5.69	6.16	6.64	7.11
6.5	5.84	6.32	6.80	7.28
6.6	5.99	6.48	6.97	7.46
6.7	6.14	6.64	7.13	7.63
6.8	6.30	6.80	7.30	7.81
6.9	6.46	6.96	7.47	7.99
7.0	6.61	7.13	7.65	8.17
7.1	6.77	7.30	7.82	8.35
7.2	6.93	7.47	8.00	8.53
7.3	7.10	7.64	8.18	8.72
7.4	7.26	7.81	8.36	8.91
7.5	7.43	7.99	8.54	9.10
7.6	7.60	8.16	8.73	9.29
7.7	7.77	8.34	8.91	9.48
7.8	7.94	8.52	9.10	9.68
7.9	8.12	8.70	9.29	9.87
8.0	8.30	8.89	9.48	10.07
8.1	8.48	9.07	9.67	10.27
8.2	8.66	9.26	9.87	10.48
8.3	8.84	9.45	10.07	10.68
8.4	9.02	9.64	10.27	10.89
8.5	9.21	9.84	10.47	11.10
8.6	9.40	10.03	10.67	11.31
8.7	9.59	10.23	10.87	11.52
8.8	9.78	10.43	11.08	11.73
8.9	9.97	10.63	11.29	11.95
9.0	10.17	10.83	11.50	12.17
9.1	10.36	11.04	11.71	12.39
9.2	10.56	11.24	11.93	12.61
9.3	10.76	11.45	12.14	12.83
9.4	10.97	11.66	12.36	13.06
9.5	11.18	11.87	12.58	13.29
9.6	11.38	12.09	12.80	13.51
9.7	11.59	12.30	13.02	13.74
9.8	11.80	12.52	13.25	13.97
9.9	12.01	12.74	13.47	14.21
10.0	12.22	12.96	13.70	14.44

Table AL11-5. End area tables for earthfill dams cubic yards per foot for embankment.

(Sheet 1 of 8)



FILL HEIGHT	SIDE SLOPES 2 ½ : 1 AND 2 ½ : 1		
	TOP WIDTH (feet)		
	10	12	14
10.1	13.19	13.93	14.68
10.2	13.41	14.17	14.92
10.3	13.64	14.40	15.16
10.4	13.87	14.64	15.41
10.5	14.10	14.87	15.65
10.6	14.33	15.11	15.90
10.7	14.56	15.36	16.15
10.8	14.80	15.60	16.40
10.9	15.04	15.85	16.65
11.0	15.28	16.09	16.91
11.1	15.52	16.34	17.16
11.2	15.76	16.59	17.42
11.3	16.01	16.85	17.68
11.4	16.26	17.10	17.94
11.5	16.50	17.36	18.21
11.6	16.76	17.61	18.47
11.7	17.01	17.87	18.74
11.8	17.26	18.14	19.01
11.9	17.52	18.40	19.28
12.0	17.78	18.67	19.56
12.1	18.04	18.93	19.83
12.2	18.30	19.20	20.11
12.3	18.56	19.47	20.39
12.4	18.83	19.75	20.67
12.5	19.10	20.02	20.95
12.6	19.37	20.30	21.23
12.7	19.64	20.58	21.52
12.8	19.91	20.86	21.81
12.9	20.19	21.14	22.10
13.0	20.46	21.43	22.39
13.1	20.74	21.71	22.68
13.2	21.02	22.00	22.98
13.3	21.30	22.29	23.27
13.4	21.59	22.58	23.57
13.5	21.87	22.87	23.87
13.6	22.16	23.17	24.18
13.7	22.45	23.47	24.48
13.8	22.74	23.77	24.79
13.9	23.04	24.07	25.10
14.0	23.33	24.37	25.41
14.1	23.63	24.67	25.72
14.2	23.93	24.98	26.03
14.3	24.23	25.29	26.35
14.4	24.53	25.60	26.67
14.5	24.84	25.91	26.99
14.6	25.14	26.23	27.31
14.7	25.45	26.54	27.63
14.8	25.76	26.86	27.96
14.9	26.07	27.18	28.28
15.0	26.39	27.50	28.61

FILL HEIGHT	SIDE SLOPES 2 ½ : 1 AND 2 ½ : 1		
	TOP WIDTH (feet)		
	10	12	14
15.1	26.70	27.82	28.94
15.2	27.02	28.15	29.27
15.3	27.34	28.47	29.61
15.4	27.66	28.80	29.94
15.5	27.99	29.13	30.28
15.6	28.31	29.47	30.62
15.7	28.64	29.80	30.96
15.8	28.97	30.14	31.31
15.9	29.30	30.47	31.65
16.0	29.63	30.81	32.00
16.1	29.96	31.16	32.35
16.2	30.30	31.50	32.70
16.3	30.64	31.85	33.05
16.4	30.98	32.19	33.41
16.5	31.32	32.54	33.76
16.6	31.66	32.89	34.12
16.7	32.01	33.25	34.48
16.8	32.36	33.60	34.84
16.9	32.70	33.96	35.21
17.0	33.06	34.31	35.57
17.1	33.41	34.67	35.94
17.2	33.76	35.04	36.31
17.3	34.12	35.40	36.68
17.4	34.48	35.77	37.06
17.5	34.84	36.13	37.43
17.6	35.20	36.50	37.81
17.7	35.56	36.87	38.19
17.8	35.93	37.25	38.57
17.9	36.30	37.62	38.95
18.0	36.67	38.00	39.33
18.1	37.04	38.38	39.72
18.2	37.41	38.76	40.11
18.3	37.79	39.14	40.50
18.4	38.16	39.53	40.89
18.5	38.54	39.91	41.28
18.6	38.92	40.30	41.88
18.7	39.30	40.69	42.07
18.8	39.69	41.08	42.47
18.9	40.07	41.47	42.87
19.0	40.46	41.87	43.28
19.1	40.85	42.27	43.88
19.2	41.24	42.67	44.09
19.3	41.64	43.07	44.50
19.4	42.03	43.47	44.91
19.5	42.43	43.87	45.32
19.6	42.83	44.28	45.73
19.7	43.23	44.69	46.15
19.8	43.63	45.10	46.57
19.9	44.04	45.51	46.99
20.0	44.44	45.93	47.41

(Sheet 2 of 8)

Table AL11-5. End area tables for earthfill dams cubic yards per foot for embankment.

AL11-60(22)

(210-VI-NEH, Amend. AL6, October 2008)



FILL HEIGHT	SIDE SLOPES 2 1/2 : 1 AND 2 1/2 : 1		
	TOP WIDTH (feet)		
	10	12	14
20.1	44.85	46.34	47.83
20.2	45.26	46.76	48.26
20.3	45.67	47.18	48.68
20.4	46.09	47.60	49.11
20.5	46.50	48.02	49.54
20.6	46.92	48.45	49.97
20.7	47.34	48.87	50.41
20.8	47.76	49.30	50.84
20.9	48.19	49.73	51.28
21.0	48.61	50.17	51.72
21.1	49.04	50.60	52.16
21.2	49.47	51.04	50.61
21.3	49.90	51.47	53.05
21.4	50.33	51.91	53.50
21.5	50.76	52.36	53.95
21.6	51.20	52.80	54.40
21.7	51.64	53.25	54.85
21.8	52.08	53.69	55.31
21.9	52.52	54.14	55.76
22.0	52.96	54.59	56.22
22.1	53.41	55.05	56.68
22.2	53.86	55.50	57.14
22.3	54.30	55.96	57.61
22.4	54.76	56.41	58.07
22.5	55.21	56.87	58.54
22.6	55.66	57.34	59.01
22.7	56.12	57.80	59.48
22.8	56.58	58.27	59.96
22.9	57.04	58.73	60.43
23.0	57.50	59.20	60.91
23.1	57.96	59.67	61.39
23.2	58.43	60.15	61.87
23.3	58.90	60.62	62.35
23.4	59.37	61.10	62.83
23.5	59.84	61.58	63.32
23.6	60.31	62.06	63.81
23.7	60.79	62.54	64.30
23.8	61.26	63.03	64.79
23.9	61.74	63.51	65.28
24.0	62.22	64.00	65.78
24.1	62.70	64.49	66.27
24.2	63.19	64.98	66.77
24.3	63.67	65.47	67.27
24.4	64.16	65.97	67.78
24.5	64.65	66.47	68.28
24.6	65.14	66.97	68.79
24.7	65.64	67.47	69.30
24.8	66.13	67.97	69.81
24.9	66.63	68.47	70.32
25.0	67.13	68.98	70.83

FILL HEIGHT	SIDE SLOPES 2 1/2 : 1 AND 2 1/2 : 1		
	TOP WIDTH (feet)		
	10	12	14
25.1	67.63	89.49	71.35
25.2	68.13	70.00	71.87
25.3	68.64	70.51	72.39
25.4	69.14	71.03	72.91
25.5	69.65	71.54	73.43
25.6	70.16	72.06	73.96
25.7	70.67	72.58	74.48
25.8	71.19	73.10	75.01
25.9	71.70	73.62	75.54
26.0	72.22	74.15	76.07
26.1	72.74	74.67	76.61
26.2	73.26	75.20	77.14
26.3	73.79	75.73	77.68
26.4	74.31	76.27	78.22
26.5	74.84	76.80	78.76
26.6	75.37	77.34	79.31
26.7	75.90	77.87	79.85
26.8	76.43	78.41	80.40
26.9	76.96	78.96	80.95
27.0	77.50	79.50	81.50
27.1	78.04	80.05	82.05
27.2	78.58	80.59	82.61
27.3	79.12	81.14	93.16
27.4	79.66	81.69	83.72
27.5	80.21	82.25	84.28
27.6	80.76	82.80	84.84
27.7	81.30	83.36	85.41
27.8	81.86	83.91	85.97
27.9	82.41	84.47	86.54
28.0	82.96	85.04	87.11
28.1	83.52	85.60	87.68
28.2	84.08	86.17	88.26
28.3	84.64	86.73	88.83
28.4	85.20	87.30	89.41
28.5	85.76	87.87	89.99
28.6	86.33	88.45	90.57
28.7	86.90	89.02	91.15
28.8	87.47	89.60	91.73
28.9	88.04	90.18	92.32
29.0	88.61	90.76	92.91
29.1	89.19	91.34	93.50
29.2	89.76	91.93	94.09
29.3	90.34	92.51	94.68
29.4	90.92	93.10	95.28
29.5	91.50	93.69	95.87
29.6	92.09	94.28	96.47
29.7	92.67	94.87	97.07
29.8	93.26	95.47	97.68
29.9	93.85	96.07	98.28
30.0	94.44	96.67	98.89

Table AL11-5. End area tables for earthfill dams cubic yards per foot for embankment.

(Sheet 3 of 8)



FILL HEIGHT	SIDE SLOPES 2 1/2 : 1 AND 2 1/2 : 1		
	TOP WIDTH (feet)		
	10	12	14
30.1	95.04	97.27	99.50
30.2	95.63	97.87	100.11
30.3	96.23	98.47	100.72
30.4	96.83	99.08	101.33
30.5	97.43	99.69	101.95
30.6	98.03	100.30	102.57
30.7	98.64	100.91	103.19
30.8	99.24	101.53	103.81
30.9	99.85	102.14	104.43
31.0	100.46	102.76	105.06
31.1	101.07	103.38	105.68
31.2	101.69	104.00	106.31
31.3	102.30	104.62	106.94
31.4	102.92	105.25	107.57
31.5	103.54	105.87	108.21
31.6	104.16	106.50	108.84
31.7	104.79	107.13	109.48
31.8	105.41	107.77	111.12
31.9	106.04	108.40	111.76
32.0	106.67	109.04	111.41
32.1	107.30	109.67	112.05
32.2	107.93	110.31	112.70
32.3	108.56	110.96	113.35
32.4	109.20	111.60	114.00
32.5	109.84	112.25	114.65
32.6	110.48	112.89	115.31
32.7	111.12	113.54	115.96
32.8	111.76	114.19	116.62
32.9	112.41	114.85	117.28
33.0	113.06	115.50	117.94
33.1	113.70	116.16	118.61
33.2	114.36	116.81	119.27
33.3	115.01	117.47	119.94
33.4	115.66	118.14	120.61
33.5	116.32	118.80	121.28
33.6	116.98	119.47	121.96
33.7	117.64	120.13	122.63
33.8	118.30	120.80	123.31
33.9	118.96	121.47	123.99
34.0	119.63	122.15	124.67
34.1	120.30	122.82	125.35
34.2	120.97	123.50	126.03
34.3	121.64	124.18	126.72
34.4	122.31	124.86	127.41
34.5	122.99	125.54	128.10
34.6	123.66	126.23	128.79
34.7	124.34	126.91	129.48
34.8	125.02	127.60	130.18
34.9	125.70	128.29	130.87
35.0	126.39	128.98	131.57

FILL HEIGHT	SIDE SLOPES 2 1/2 : 1 AND 2 1/2 : 1		
	TOP WIDTH (feet)		
	10	12	14
35.1	127.07	129.67	132.27
35.2	127.76	130.37	132.98
35.3	128.45	131.07	133.68
35.4	129.14	131.77	134.39
35.5	129.84	132.47	135.10
35.6	130.53	133.17	135.81
35.7	131.23	133.87	136.52
35.8	131.93	134.58	137.23
35.9	132.63	135.29	137.95
36.0	133.33	136.00	138.67
36.1	134.04	136.71	139.39
36.2	134.74	137.43	140.11
36.3	135.45	138.14	140.83
36.4	136.16	138.86	141.56
36.5	136.87	139.58	142.28
36.6	137.59	140.30	143.01
36.7	138.30	141.02	143.74
36.8	139.02	141.75	144.47
36.9	139.74	142.47	145.21
37.0	140.46	143.20	145.94
37.1	141.19	143.93	146.88
37.2	141.91	144.67	147.42
37.3	142.64	145.40	148.16
37.4	143.37	146.14	148.91
37.5	144.10	146.87	149.65
37.6	144.83	147.61	150.40
37.7	145.56	148.36	151.15
37.8	146.30	149.10	151.90
37.9	147.04	149.85	152.65
38.0	147.78	150.59	153.41
38.1	148.52	151.34	154.18
38.2	149.26	152.09	154.92
38.3	150.01	152.85	155.68
38.4	150.76	153.60	156.44
38.5	151.50	154.36	157.21
38.6	152.26	155.11	157.97
38.7	153.01	155.87	158.74
38.8	153.76	156.64	159.51
38.9	154.52	157.40	160.28
39.0	155.28	158.17	161.06
39.1	156.04	158.93	161.83
39.2	156.80	159.70	162.61
39.3	157.56	160.47	163.39
39.4	158.33	161.25	164.17
39.5	159.10	162.02	164.95
39.6	159.87	162.80	165.73
39.7	160.64	163.58	166.52
39.8	161.41	164.36	167.31
39.9	162.19	165.14	168.10
40.0	162.96	165.93	168.89

(Sheet 4 of 8)

Table AL11-5. End area tables for earthfill dams cubic yards per foot for embankment.  
AL11-60(24)

(210-VI-NEH, Amend. AL6, October 2008)



FILL HEIGHT	SIDE SLOPES 3:1 AND 3:1			
	TOP WIDTH (feet)			
	8	10	12	14
0.1	0.03	0.04	0.05	0.05
0.2	0.06	0.08	0.09	0.11
0.3	0.10	0.12	0.14	0.17
0.4	0.14	0.17	0.20	0.23
0.5	0.18	0.21	0.25	0.29
0.6	0.22	0.26	0.31	0.35
0.7	0.26	0.31	0.37	0.42
0.8	0.31	0.37	0.43	0.49
0.9	0.36	0.42	0.49	0.56
1.0	0.41	0.48	0.56	0.63
1.1	0.46	0.54	0.62	0.70
1.2	0.52	0.60	0.69	0.78
1.3	0.57	0.67	0.77	0.86
1.4	0.63	0.74	0.84	0.94
1.5	0.69	0.81	0.92	1.03
1.6	0.76	0.88	1.00	1.11
1.7	0.83	0.95	1.08	1.20
1.8	0.89	1.03	1.16	1.29
1.9	0.96	1.10	1.25	1.39
2.0	1.04	1.19	1.33	1.48
2.1	1.11	1.27	1.42	1.58
2.2	1.19	1.35	1.52	1.68
2.3	1.27	1.44	1.61	1.78
2.4	1.35	1.53	1.71	1.88
2.5	1.43	1.62	1.81	1.99
2.6	1.52	1.71	1.91	2.10
2.7	1.61	1.81	2.01	2.21
2.8	1.70	1.91	2.12	2.32
2.9	1.79	2.01	2.22	2.44
3.0	1.89	2.11	2.33	2.56
3.1	1.99	2.22	2.45	2.68
3.2	2.09	2.32	2.56	2.80
3.3	2.10	2.43	2.68	2.92
3.4	2.30	2.54	2.80	3.05
3.5	2.40	2.66	2.92	3.18
3.6	2.51	2.77	3.04	3.31
3.7	2.62	2.89	3.17	3.44
3.8	2.73	3.01	3.29	3.57
3.9	2.85	3.13	3.42	3.71
4.0	2.96	3.26	3.56	3.85
4.1	3.08	3.39	3.69	3.99
4.2	3.20	3.52	3.83	4.14
4.3	3.32	3.65	3.97	4.28
4.4	3.45	3.78	4.11	4.43
4.5	3.58	3.92	4.25	4.58
4.6	3.71	4.05	4.40	4.74
4.7	3.84	4.20	4.54	4.89
4.8	3.98	4.34	4.69	5.05
4.9	4.12	4.48	4.85	5.21
5.0	4.26	4.63	5.00	5.37

FILL HEIGHT	SIDE SLOPES 3:1 AND 3:1			
	TOP WIDTH (feet)			
	8	10	12	14
5.1	4.40	4.78	5.16	5.53
5.2	4.55	4.93	5.32	5.70
5.3	4.70	5.08	5.48	5.87
5.4	4.84	5.24	5.64	6.04
5.5	4.99	5.40	5.81	6.21
5.6	5.14	5.56	5.97	6.39
5.7	5.30	5.72	6.14	6.57
5.8	5.46	5.89	6.32	6.75
5.9	5.62	6.05	6.49	6.93
6.0	5.78	6.22	6.67	7.11
6.1	5.94	6.39	6.85	7.30
6.2	6.11	6.57	7.03	7.49
6.3	6.29	6.74	7.21	7.68
6.4	6.48	6.92	7.40	7.87
6.5	6.64	7.10	7.58	8.06
6.6	6.80	7.28	7.77	8.26
6.7	6.97	7.47	7.97	8.46
6.8	7.15	7.66	8.16	8.66
6.9	7.34	7.85	8.36	8.87
7.0	7.52	8.04	8.56	9.07
7.1	7.71	8.23	8.76	9.28
7.2	7.89	8.43	8.96	9.49
7.3	8.08	8.62	9.17	9.71
7.4	8.28	8.83	9.37	9.92
7.5	8.47	9.03	9.58	10.14
7.6	8.67	9.23	9.80	10.36
7.7	8.87	9.44	10.01	10.58
7.8	9.07	9.65	10.23	10.80
7.9	9.28	9.86	10.45	11.03
8.0	9.48	10.07	10.67	11.26
8.1	9.69	10.29	10.89	11.49
8.2	9.90	10.51	11.12	11.72
8.3	10.11	10.73	11.34	11.96
8.4	10.33	10.95	11.57	12.20
8.5	10.55	11.18	11.81	12.44
8.6	10.77	11.40	12.04	12.68
8.7	10.99	11.63	12.28	12.92
8.8	11.21	11.86	12.52	13.17
8.9	11.44	12.10	12.76	13.42
9.0	11.67	12.33	13.00	13.67
9.1	11.90	12.57	13.25	13.92
9.2	12.13	12.81	13.49	14.17
9.3	12.36	13.05	13.74	14.43
9.4	12.60	13.30	14.00	14.69
9.5	12.84	13.55	14.25	14.95
9.6	13.08	13.80	14.51	15.22
9.7	13.33	14.05	14.77	15.48
9.8	13.57	14.30	15.03	15.75
9.9	13.82	14.56	15.29	16.02
10.0	14.07	14.81	15.56	16.30

(Sheet 5 of 8)

Table AL11-5. End area tables for earthfill dams cubic yards per foot for embankment.

AL11-60(25)

(210-VI-NEH, Amend. AL6, October 2008)



FILL HEIGHT	SIDE SLOPES 3:1 AND 3:1		
	TOP WIDTH (feet)		
	10	12	14
10.1	15.08	15.82	16.57
10.2	15.34	16.09	16.85
10.3	15.60	16.37	17.13
10.4	15.87	16.64	17.41
10.5	16.14	16.92	17.69
10.6	16.41	17.20	17.98
10.7	16.68	17.48	18.27
10.8	16.96	17.76	18.56
10.9	17.24	18.05	18.85
11.0	17.52	18.33	19.15
11.1	17.80	18.62	19.45
11.2	18.09	18.92	19.75
11.3	18.37	19.21	20.05
11.4	18.66	19.51	20.35
11.5	18.95	19.81	20.66
11.6	19.25	20.11	20.97
11.7	19.54	20.41	21.28
11.8	19.84	20.72	21.59
11.9	20.14	21.02	21.90
12.0	20.44	21.33	22.22
12.1	20.75	21.65	22.54
12.2	21.06	21.96	22.86
12.3	21.37	22.28	23.19
12.4	21.68	22.60	23.51
12.5	21.99	22.92	23.84
12.6	22.31	23.24	24.17
12.7	22.62	23.57	24.51
12.8	22.95	23.89	24.84
12.9	23.27	24.22	25.18
13.0	23.59	24.56	25.52
13.1	23.92	24.89	25.86
13.2	24.25	25.23	26.20
13.3	24.58	25.57	26.55
13.4	24.91	25.91	26.90
13.5	25.25	26.25	27.25
13.6	25.59	26.60	27.60
13.7	25.93	26.94	27.96
13.8	26.27	27.29	28.32
13.9	26.62	27.65	28.68
14.0	26.96	28.00	29.04
14.1	27.31	28.36	29.40
14.2	27.66	28.72	29.77
14.3	28.02	29.08	30.14
14.4	28.37	29.44	30.51
14.5	28.73	29.81	30.88
14.6	29.09	30.17	31.25
14.7	29.45	30.54	31.63
14.8	29.82	30.92	32.01
14.9	30.19	31.29	32.39
15.0	30.56	31.67	32.78

FILL HEIGHT	SIDE SLOPES 3:1 AND 3:1		
	TOP WIDTH (feet)		
	10	12	14
15.1	30.93	32.05	33.16
15.2	31.30	32.43	33.55
15.3	31.68	32.81	33.94
15.4	32.05	33.20	34.34
15.5	32.44	33.58	34.73
15.6	32.82	33.97	35.13
15.7	33.20	34.37	35.53
15.8	33.59	34.76	35.93
15.9	33.98	35.16	36.33
16.0	34.37	35.56	36.74
16.1	34.76	35.96	37.15
16.2	35.16	36.36	37.56
16.3	35.56	36.77	37.97
16.4	35.96	37.17	38.39
16.5	36.36	37.58	38.81
16.6	36.77	38.00	39.23
16.7	37.17	38.41	39.65
16.8	37.58	38.83	40.07
16.9	37.99	39.25	40.50
17.0	38.41	39.67	40.93
17.1	38.82	40.09	41.36
17.2	39.24	40.52	41.79
17.3	39.66	40.94	42.22
17.4	40.08	41.37	42.66
17.5	40.51	41.81	43.10
17.6	40.94	42.24	43.54
17.7	41.37	42.68	43.99
17.8	41.80	43.12	44.43
17.9	42.23	43.56	44.88
18.0	42.67	44.00	45.33
18.1	43.10	44.45	45.79
18.2	43.55	44.89	46.24
18.3	43.99	45.34	46.70
18.4	44.43	45.80	47.16
18.5	44.88	46.25	47.62
18.6	45.33	46.71	48.08
18.7	45.78	47.17	48.55
18.8	46.23	47.63	49.02
18.9	46.69	48.09	49.49
19.0	47.15	48.56	49.96
19.1	47.61	49.02	50.44
19.2	48.07	49.49	50.92
19.3	48.54	49.97	51.40
19.4	49.00	50.44	51.88
19.5	49.47	50.92	52.36
19.6	49.94	51.40	52.85
19.7	50.42	51.88	53.34
19.8	50.89	52.36	53.83
19.9	51.37	52.85	54.32
20.0	51.85	53.33	54.81

(Sheet 6 of 8)

Table AL11-5. End area tables for earthfill dams cubic yards per foot for embankment.  
AL11-60(26)

(210-VI-NEH, Amend. AL6, October 2008)



FILL HEIGHT	SIDE SLOPES 3:1 AND 3:1		
	TOP WIDTH (feet)		
	10	12	14
20.1	52.33	53.82	55.31
20.2	52.82	54.32	55.81
20.3	53.31	54.81	56.31
20.4	53.80	55.31	56.82
20.5	54.29	55.81	57.32
20.6	54.78	56.31	57.83
20.7	55.28	56.81	58.34
20.8	55.77	57.32	58.86
20.9	56.28	57.82	59.37
21.0	56.78	58.33	59.89
21.1	57.28	58.85	60.41
21.2	57.79	59.36	60.93
21.3	58.30	59.88	61.45
21.4	58.81	60.40	61.98
21.5	59.32	60.92	62.51
21.6	59.84	61.44	63.04
21.7	60.36	61.97	63.57
21.8	60.88	62.49	64.11
21.9	61.40	63.02	64.65
22.0	61.93	63.56	65.19
22.1	62.45	64.09	65.73
22.2	62.98	64.63	66.27
22.3	63.51	65.17	66.82
22.4	64.05	65.71	67.37
22.5	64.58	66.25	67.92
22.6	65.12	66.80	68.47
22.7	65.66	67.34	69.02
22.8	66.20	67.89	69.58
22.9	66.75	68.45	70.14
23.0	67.30	69.00	70.70
23.1	67.85	69.56	71.27
23.2	68.40	70.12	71.83
23.3	68.95	70.68	72.40
23.4	69.51	71.24	72.97
23.5	70.06	71.81	73.55
23.6	70.63	72.37	74.12
23.7	71.19	72.94	74.70
23.8	71.75	73.52	75.28
23.9	72.32	74.09	75.86
24.0	72.89	74.67	76.44
24.1	73.46	75.25	77.03
24.2	74.03	75.83	77.62
24.3	74.61	76.41	78.21
24.4	75.19	77.00	78.80
24.5	75.77	77.58	79.40
24.6	76.35	78.17	80.00
24.7	76.94	78.77	80.60
24.8	77.52	79.36	81.20
24.9	78.11	79.96	81.80
25.0	78.70	80.56	82.41

FILL HEIGHT	SIDE SLOPES 3:1 AND 3:1		
	TOP WIDTH (feet)		
	10	12	14
25.1	79.30	81.16	83.02
25.2	79.89	81.76	83.63
25.3	80.49	82.37	84.24
25.4	81.09	82.97	84.85
25.5	81.69	83.58	85.47
25.6	82.30	84.20	86.09
25.7	82.91	84.81	86.71
25.8	83.52	85.43	87.34
25.9	84.13	86.05	87.96
26.0	84.74	86.67	88.59
26.1	85.36	87.29	89.22
26.2	85.97	87.92	89.86
26.3	86.60	88.54	90.49
26.4	87.22	89.17	91.13
26.5	87.84	89.81	91.77
26.6	88.47	90.44	92.41
26.7	89.10	91.08	93.05
26.8	89.73	91.72	93.70
26.9	90.36	92.36	94.35
27.0	91.00	93.00	95.00
27.1	91.64	93.65	95.65
27.2	92.28	94.29	96.31
27.3	92.92	94.94	96.97
27.4	93.57	95.60	97.63
27.5	94.21	96.25	98.29
27.6	94.88	96.91	98.95
27.7	95.51	97.57	99.62
27.8	96.17	98.23	100.29
27.9	96.82	98.89	100.96
28.0	97.48	99.56	101.63
28.1	98.14	100.22	102.30
28.2	98.80	100.89	102.98
28.3	99.47	101.57	103.66
28.4	100.14	102.24	104.34
28.5	100.81	102.92	105.03
28.6	101.48	103.60	105.71
28.7	102.15	104.28	106.40
28.8	102.83	104.96	107.09
28.9	103.50	105.65	107.79
29.0	104.19	106.33	108.48
29.1	104.87	107.02	109.18
29.2	105.55	107.72	109.88
29.3	106.24	108.41	110.58
29.4	106.93	109.11	111.28
29.5	107.62	109.81	111.99
29.6	108.31	110.51	112.70
29.7	109.01	111.21	113.41
29.8	109.71	111.92	114.12
29.9	110.41	112.62	114.84
30.0	111.11	113.33	115.56

(Sheet 7 of 8)

Table AL11-5. End area tables for earthfill dams cubic yards per foot for embankment.

AL11-60(27)

(210-VI-NEH, Amend. AL6, October 2008)



FILL HEIGHT	SIDE SLOPES 3:1 AND 3:1		
	TOP WIDTH (feet)		
	10	12	14
30.1	111.32	114.05	116.28
30.2	112.52	114.76	117.00
30.3	113.23	115.48	117.72
30.4	113.94	116.20	118.45
30.5	114.66	116.92	119.18
30.6	115.37	117.64	119.91
30.7	116.09	118.37	120.64
30.8	116.81	119.09	121.37
30.9	117.53	119.82	122.11
31.0	118.26	120.56	122.85
31.1	118.99	121.29	123.59
31.2	119.72	122.03	124.34
31.3	120.45	122.77	125.08
31.4	121.18	123.51	125.83
31.5	121.92	124.25	126.58
31.6	122.65	125.00	127.34
31.7	123.40	125.74	128.09
31.8	124.14	126.49	128.85
31.9	124.88	127.25	129.61
32.0	125.63	128.00	130.37
32.1	126.38	128.76	131.13
32.2	127.13	129.52	131.90
32.3	127.88	130.28	132.67
32.4	128.64	131.04	133.44
32.5	129.40	131.81	134.21
32.6	130.16	132.57	134.99
32.7	130.92	133.34	135.77
32.8	131.69	134.12	136.54
32.9	132.45	134.89	137.33
33.0	133.22	135.67	138.11
33.1	133.99	135.45	138.90
33.2	134.77	137.23	139.69
33.3	135.54	138.01	140.48
33.4	136.32	138.80	141.27
33.5	137.10	139.58	142.06
33.6	137.88	140.37	142.86
33.7	138.67	141.17	143.66
33.8	139.46	141.96	144.46
33.9	140.25	142.76	145.27
34.0	141.04	143.56	146.07
34.1	141.83	144.36	146.88
34.2	142.63	145.16	147.69
34.3	143.42	145.97	148.51
34.4	144.22	146.77	149.32
34.5	145.03	147.58	150.14
34.6	145.83	148.40	150.96
34.7	146.64	149.21	151.78
34.8	147.45	150.03	152.60
34.9	148.26	150.85	153.43
35.0	149.07	151.67	154.26

FILL HEIGHT	SIDE SLOPES 3:1 AND 3:1		
	TOP WIDTH (feet)		
	10	12	14
35.1	149.89	152.49	155.09
35.2	150.71	153.32	155.92
35.3	151.53	154.14	156.76
35.4	152.35	154.97	157.60
35.5	153.18	155.81	158.43
35.6	154.00	156.64	159.28
35.7	154.83	157.48	160.12
35.8	155.66	158.32	160.97
35.9	156.50	159.16	161.82
36.0	157.33	160.00	162.67
36.1	158.17	160.85	163.52
36.2	159.01	161.69	164.37
36.3	159.85	162.54	165.23
36.4	160.70	163.40	166.09
36.5	161.55	164.25	166.95
36.6	162.40	165.11	167.82
36.7	163.25	165.97	168.68
36.8	164.10	166.83	169.55
36.9	164.96	167.69	170.42
37.0	165.81	168.56	171.30
37.1	166.87	169.42	172.17
37.2	167.54	170.29	173.05
37.3	168.40	171.17	173.93
37.4	169.27	172.04	174.81
37.5	170.14	172.92	175.69
37.6	171.01	173.80	176.58
37.7	171.88	174.68	177.47
37.8	172.76	175.56	178.36
37.9	173.64	176.45	179.25
38.0	174.52	177.33	180.15
38.1	175.40	178.22	181.05
38.2	176.29	179.12	181.94
38.3	177.17	180.01	182.85
38.4	178.06	180.91	183.75
38.5	178.95	181.81	184.66
38.6	179.85	182.71	185.57
38.7	180.74	183.61	186.48
38.8	181.64	184.52	187.39
38.9	182.54	185.42	188.30
39.0	183.44	186.33	189.22
39.1	184.35	187.25	190.14
39.2	185.26	188.16	191.06
39.3	186.17	189.08	191.99
39.4	187.08	190.00	192.91
39.5	187.99	190.92	193.84
39.6	188.91	191.84	194.77
39.7	189.82	192.77	195.71
39.8	190.74	193.69	196.64
39.9	191.67	194.62	197.58
40.0	192.59	195.56	198.52

(Sheet 8 of 8)

Table AL11-5. End area tables for earthfill dams cubic yards per foot for embankment.  
AL11-60(28)

(210-VI-NEH, Amend. AL6, October 2008)



NO. OF CATTLE	WATER NEEDS FOR CATTLE IN ACRE FEET PER				
	60 Days	90 Days	120 Days	180 Days	270 Days
5	0.014	0.021	0.028	0.041	0.062
10	0.028	0.042	0.055	0.083	0.124
15	0.042	0.062	0.083	0.124	0.186
20	0.055	0.083	0.110	0.166	0.249
25	0.069	0.104	0.138	0.207	0.311
30	0.083	0.124	0.166	0.249	0.373
35	0.097	0.145	0.193	0.290	0.435
40	0.110	0.166	0.221	0.331	0.497
45	0.124	0.186	0.248	0.373	0.559
50	0.138	0.207	0.276	0.414	0.621
60	0.166	0.249	0.331	0.497	0.746
70	0.193	0.290	0.387	0.580	0.870
80	0.221	0.331	0.442	0.663	0.994
90	0.249	0.373	0.497	0.746	1.119
100	0.276	0.414	0.552	0.829	1.243
120	0.331	0.497	0.663	0.994	1.491
140	0.387	0.580	0.773	1.160	1.740
160	0.442	0.663	0.884	1.326	1.988
180	0.497	0.746	0.994	1.491	2.237

Formula for needs for cattle: Acre Feet = \_\_\_\_\_ Head x 15 Gal. x \_\_\_\_\_ days

325,848

Table AL11-6. Water needs for cattle.



Surface Area of Pond		Seepage and Evaporation Losses in Acre Feet per days				
Dimensions (Sq. Ft.)	Acres	60	90	120	180	270
40 X 40 (1,600)	0.037	0.044	0.066	0.088	0.132	0.197
40 x 60 (2,400)	0.055	0.066	0.099	0.132	0.197	0.296
40 x 75 (3,000)	0.069	0.082	0.123	0.165	0.247	0.370
40 x 100 (4,000)	0.092	0.110	0.165	0.219	0.329	0.494
50 x 60 (3,000)	0.069	0.082	0.123	0.165	0.247	0.370
50 x 75 (3,750)	0.086	0.103	0.154	0.206	0.308	0.463
50 x 90 (4,500)	0.103	0.123	0.185	0.247	0.370	0.555
60 x 80 (4,800)	0.110	0.132	0.197	0.263	0.395	0.592
60 x 90 (5,400)	0.124	0.148	0.222	0.296	0.444	0.666
60 x 100 (6,000)	0.138	0.165	0.247	0.329	0.494	0.740
65 x 105 (6,825)	0.156	0.187	0.281	0.374	0.561	0.842
70 x 100 (7,000)	0.161	0.193	0.288	0.384	0.576	0.864
80 x 100 (8,000)	0.184	0.219	0.329	0.439	0.658	0.987
90 x 100 (9,000)	0.207	0.247	0.370	0.494	0.740	1.111
80 x 125 (10,000)	0.230	0.274	0.411	0.548	0.823	1.234
100 x 100 (10,000)	0.230	0.274	0.411	0.548	0.823	1.234
100 x 125 (12,500)	0.287	0.343	0.514	0.686	1.028	1.542
120 x 125 (15,000)	0.344	0.411	0.617	0.823	1.234	1.851
(21,780)	0.500	0.597	0.896	1.194	1.792	2.688
(32,670)	0.750	0.896	1.344	1.792	2.688	4.031
(43,560)	1.000	1.194	1.792	2.389	3.583	5.375
(65,340)	1.500	1.792	2.688	3.583	5.375	8.063
(87,120)	2.000	2.389	3.583	4.778	7.167	10.750

Formula for Evaporation and Seepage Losses: = \_\_\_\_\_ Acres (\_\_\_\_ Months x 50 + \_\_\_\_ Months x 3) = \_\_\_\_\_ A.F.

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= \_\_\_\_\_ Acres x 0.597 \_\_\_\_\_ Months = Acre Feet.

Table AL11-7. Seepage and evaporation losses.

AL11-60(30)

(210-VI-NEH, Amend. AL6, October 2008)



**Storage - Acre Feet and Surface Area - Acres  
4:1 and 2:1 End Slopes and 1:1 Side Slopes**

<b>TOP DIMENSIONS (Feet) (Square Feet)</b>	<b>DEPTH (Feet)</b>	<b>BOTTOM DIMENSIONS (Feet)</b>	<b>VOLUME (Cubic Yards)</b>	<b>STORAGE (Acre Feet)</b>	<b>SURFACE AREA (Acres)</b>
40 x 40 (1600)	4	32 x 16	151.7	0.094	0.037
	5	30 x 10	166.7	0.103	
	6	28 x 4	174.2	0.108	
40 x 60 (2400)	4	32 x 36	258.4	0.160	0.055
	5	30 x 30	296.3	0.183	
	6	28 x 24	325.3	0.202	
	7	26 x 18	346.4	0.215	
40 x 75 (3000)	4	32 x 51	338.4	0.210	0.069
	5	30 x 45	393.5	0.244	
	6	28 x 39	438.7	0.272	
	7	26 x 33	474.7	0.294	
	8	24 x 27	502.5	0.311	
40 x 100 (4000)	4	32 x 76	471.7	0.292	0.092
	5	30 x 70	555.5	0.344	
	6	28 x 64	627.6	0.389	
	7	26 x 58	688.6	0.427	
	8	24 x 52	739.6	0.458	
50 x 60 (3000)	4	42 x 36	329.5	0.204	0.069
	5	40 x 30	379.6	0.235	
	6	38 x 24	418.7	0.259	
	7	36 x 18	447.5	0.277	
50 x 75 (3750)	5	40 x 45	504.6	0.313	0.086
	6	38 x 39	565.3	0.350	
	7	36 x 33	614.7	0.381	
	8	34 x 27	653.6	0.405	
50 x 90 (4500)	5	40 x 60	629.6	0.390	0.103
	6	38 x 54	712.0	0.441	
	7	36 x 48	781.9	0.485	
	8	34 x 42	840.3	0.521	
60 x 80 (4800)	5	50 x 50	666.7	0.413	0.110
	6	48 x 44	752.0	0.466	
	7	46 x 38	823.4	0.510	
	8	44 x 32	881.8	0.546	
60 x 90 (5400)	5	50 x 60	768.5	0.476	0.124
	6	48 x 54	872.0	0.540	
	7	46 x 48	960.8	0.595	
	8	44 x 42	1035.8	0.642	

Table AL11-8. Yardage tables - excavated ponds.

(Sheet 1 of 6)

**Storage - Acre Feet and Surface Area - Acres**  
**4:1 and 2:1 End Slopes and 1:1 Side Slopes**

<b>TOP DIMENSIONS (Feet) (Square Feet)</b>	<b>DEPTH (Feet)</b>	<b>BOTTOM DIMENSIONS (Feet)</b>	<b>VOLUME (Cubic Yards)</b>	<b>STORAGE (Acre Feet)</b>	<b>SURFACE AREA (Acres)</b>
60 x 100 (6000)	5	50 x 70	870.4	0.539	0.138
	6	48 x 64	992.0	0.615	
	7	46 x 58	1098.2	0.681	
	8	44 x 52	1189.9	0.737	
65 x 105 (6825)	5	55 x 75	1004.9	0.623	0.156
	6	53 x 69	1148.7	0.712	
	7	51 x 63	1275.8	0.791	
	8	49 x 57	1387.0	0.860	
70 x 100 (7000)	5	60 x 70	1027.8	0.637	0.161
	6	58 x 64	1174.2	0.728	
	7	56 x 58	1303.0	0.808	
	8	54 x 52	1415.1	0.877	
80 x 100 (8000)	5	70 x 70	1185.2	0.735	0.184
	6	68 x 64	1356.4	0.841	
	7	66 x 58	1507.8	0.934	
	8	64 x 52	1640.3	1.017	
90 x 100 (9000)	5	80 x 70	1342.6	0.832	0.207
	6	78 x 64	1538.7	0.954	
	7	76 x 58	1712.7	1.062	
	8	74 x 52	1865.5	1.156	
	9	72 x 46	1998.0	1.238	
100 x 100 (10,000)	5	90 x 70	1500.0	0.930	0.230
	6	88 x 64	1720.9	1.067	
	7	86 x 58	1917.5	1.188	
	8	84 x 52	2090.7	1.296	
	9	82 x 46	2241.3	1.389	
80 x 125 (10,000)	5	70 x 95	1532.4	0.950	0.230
	6	68 x 89	1767.6	1.096	
	7	66 x 83	1981.0	1.228	
	8	64 x 77	2173.6	1.347	
	9	62 x 71	2346.3	1.454	
100 x 125 (12,500)	6	88 x 89	2243.1	1.390	0.287
	7	86 x 83	2520.3	1.562	
	8	84 x 77	2772.1	1.718	
	9	82 x 71	2999.7	1.859	
	10	80 x 65	3203.7	1.986	
120 x 125 (15,000)	6	108 x 89	2718.7	1.685	0.344
	7	106 x 83	3059.5	1.896	
	8	104 x 77	3370.7	2.089	
	9	102 x 71	3653.0	2.264	
	10	100 x 65	3907.4	2.422	

Table AL11-8. Yardage tables - excavated ponds.

(Sheet 2 of 6)

**Storage - Acre Feet and Surface Area - Acres**  
**4:1 and 3:1 End Slopes and 2:1 Side Slopes**

TOP DIMENSIONS (Feet) (Square Feet)	DEPTH (Feet)	BOTTOM DIMENSIONS (Feet)	VOLUME (Cubic Yards)	STORAGE (Acre Feet)	SURFACE AREA (Acres)
40 x 40 (1600)	4 5	24 x 12 20 x 5	128.8 135.8	0.080 0.084	0.037
40 x 60 (2400)	4 5 6 7	24 x 32 20 x 25 16 x 18 12 x 11	223.6 246.9 261.3 268.0	0.139 0.153 0.162 0.166	0.055
40 x 75 (3000)	4 5 6 7 8	24 x 47 20 x 40 16 x 33 12 x 26 8 x 19	294.7 330.2 354.7 370.0 378.5	0.183 0.205 0.220 0.229 0.235	0.069
40 x 100 (4000)	4 5 6 7 8	24 x 72 20 x 65 16 x 58 12 x 51 8 x 44	413.2 469.1 510.2 538.6 556.2	0.256 0.291 0.316 0.334 0.345	0.092
50 x 60 (3000)	4 5 6 7	34 x 32 30 x 25 26 x 18 22 x 11	291.8 325.6 348.0 361.0	0.181 0.202 0.216 0.224	0.069
50 x 75 (3750)	5 6 7 8	30 x 40 26 x 33 22 x 26 18 x 19	436.7 474.7 501.0 517.7	0.271 0.294 0.311 0.321	0.086
50 x 90 (5400)	5 6 7 8	30 x 55 26 x 48 22 x 41 18 x 34	547.8 601.3 641.0 668.8	0.340 0.373 0.397 0.415	0.103
60 x 80 (4800)	5 6 7 8	40 x 45 36 x 38 32 x 31 28 x 24	589.5 648.0 691.5 722.2	0.365 0.402 0.429 0.448	0.110
60 x 90 (5400)	5 6 7 8	40 x 55 36 x 48 32 x 41 28 x 34	682.1 754.7 810.8 852.5	0.423 0.468 0.503 0.528	0.124

Table AL11-8. Yardage tables - excavated ponds.

(Sheet 3 of 6)

Storage - Acre Feet and Surface Area - Acres  
4:1 and 3:1 End Slopes and 2:1 Side Slopes

TOP DIMENSIONS (Feet) (Square Feet)	DEPTH (Feet)	BOTTOM DIMENSIONS (Feet)	VOLUME (Cubic Yards)	STORAGE (Acre Feet)	SURFACE AREA (Acres)
60 x 100 (6000)	5	40 x 65	774.7	0.480	0.138
	6	36 x 58	861.3	0.534	
	7	32 x 51	930.0	0.576	
	8	28 x 44	982.9	0.609	
65 x 105 (6825)	5	45 x 70	902.0	0.559	0.157
	6	41 x 63	1008.0	0.625	
	7	37 x 56	1094.0	0.678	
	8	33 x 49	1162.2	0.720	
70 x 100 (7000)	5	50 x 65	927.5	0.575	0.161
	6	46 x 58	1036.9	0.643	
	7	42 x 51	1125.8	0.698	
	8	38 x 44	1196.2	0.741	
80 x 100 (8000)	5	60 x 65	1080.2	0.670	0.184
	6	56 x 58	1212.4	0.751	
	7	52 x 51	1321.5	0.819	
	8	48 x 44	1409.6	0.874	
90 x 100 (9000)	5	70 x 65	1233.0	0.764	0.207
	6	66 x 58	1388.0	0.860	
	7	62 x 51	1517.3	0.940	
	8	58 x 44	1622.9	1.006	
	9	54 x 37	1707.0	1.058	
100 x 100 (10,000)	5	80 x 65	1385.8	0.859	0.230
	6	76 x 58	1563.6	0.969	
	7	72 x 51	1713.0	1.062	
	8	68 x 44	1836.2	1.138	
	9	64 x 37	1935.3	1.199	
80 x 125 (10,000)	5	60 x 90	1404.3	0.870	0.230
	6	56 x 83	1590.2	0.986	
	7	52 x 76	1749.3	1.084	
	8	48 x 69	1883.6	1.167	
	9	44 x 62	1995.3	1.237	
100 x 125 (12.500)	6	76 x 83	2052.4	1.272	0.287
	7	72 x 76	2270.4	1.407	
	8	68 x 69	2458.5	1.524	
	9	64 x 62	2618.7	1.623	
	10	60 x 55	2753.1	1.706	
120 x 125 (15,000)	6	96 x 83	2514.7	1.559	0.344
	7	92 x 76	2791.5	1.730	
	8	88 x 69	3033.3	1.880	
	9	84 x 62	3242.0	2.009	
	10	80 x 55	3419.8	2.120	

Table AL11-8. Yardage tables - excavated ponds.

(Sheet 4 of 6)

**Storage - Acre Feet and Surface Area - Acres**  
**4:1 and 3:1 End Slopes and 3:1 Side Slopes**

TOP DIMENSIONS (Feet) (Square Feet)	DEPTH (Feet)	BOTTOM DIMENSIONS (Feet)	VOLUME (Cubic Yards)	STORAGE (Acre Feet)	SURFACE AREA (Acres)
40 x 40 (1600)	4	16 x 12	116.1	0.072	0.037
	5	10 x 5	120.4	0.075	
40 x 60 (2400)	4	16 x 32	199.1	0.123	0.055
	5	10 x 25	213.0	0.132	
	6	4 x 18	218.7	0.136	
40 x 75 (3000)	4	16 x 47	261.3	0.162	0.069
	5	10 x 40	282.4	0.175	
	6	4 x 33	292.0	0.181	
40 x 100 (4000)	4	16 x 72	365.0	0.226	0.092
	5	10 x 65	398.1	0.247	
	6	4 x 58	414.2	0.257	
50 x 60 (3000)	4	26 x 32	267.3	0.166	0.069
	5	20 x 25	291.7	0.181	
	6	14 x 18	305.3	0.189	
	7	8 x 11	311.4	0.193	
50 x 75 (3750)	5	20 x 40	388.9	0.241	0.086
	6	14 x 33	412.0	0.255	
	7	8 x 26	424.1	0.263	
50 x 90 (4500)	5	20 x 55	486.1	0.301	0.103
	6	14 x 48	518.7	0.321	
	7	8 x 41	536.9	0.333	
60 x 80 (4800)	5	30 x 45	537.0	0.333	0.110
	6	24 x 38	578.7	0.359	
	7	18 x 31	605.6	0.375	
	8	12 x 24	621.0	0.385	
60 x 90 (5400)	5	30 x 55	620.4	0.385	0.124
	6	24 x 48	672.0	0.417	
	7	18 x 41	706.7	0.438	
	8	12 x 34	727.7	0.451	
60 x 100 (6000)	5	30 x 65	703.7	0.436	0.138
	6	24 x 58	765.3	0.474	
	7	18 x 51	807.9	0.501	
	8	12 x 44	834.4	0.517	
65 x 105 (6825)	5	35 x 70	826.4	0.512	0.157
	6	29 x 63	905.3	0.561	
	7	23 x 56	962.3	0.597	
	8	17 x 49	1001.8	0.621	
70 x 100 (7000)	5	40 x 65	856.5	0.531	0.161
	6	34 x 58	940.9	0.583	
	7	28 x 51	1003.6	0.622	
	8	22 x 44	1047.7	0.649	

Table AL11-8. Yardage tables - excavated ponds.

(Sheet 5 of 6)

**Storage - Acre Feet and Surface Area - Acres  
4:1 and 3:1 End Slopes and 3:1 Side Slopes**

<b>TOP DIMENSIONS (Feet) (Square Feet)</b>	<b>DEPTH (Feet)</b>	<b>BOTTOM DIMENSIONS (Feet)</b>	<b>VOLUME (Cubic Yards)</b>	<b>STORAGE (Acre Feet)</b>	<b>SURFACE AREA (Acres)</b>
80 x 100 (8000)	5 6 7 8	50 x 65 44 x 58 38 x 51 32 x 44	1009.2 1116.4 1199.3 1261.0	0.626 0.692 0.743 0.782	0.184
90 x 100 (9000)	5 6 7 8 9	60 x 65 54 x 58 48 x 51 42 x 44 36 x 37	1162.0 1292.0 1395.1 1474.4 1533.0	0.720 0.801 0.865 0.914 0.950	0.207
100 x 100 (10,000)	5 6 7 8 9	70 x 65 64 x 58 58 x 51 52 x 44 46 x 37	1314.8 1467.6 1590.8 1687.7 1761.3	0.815 0.910 0.986 1.046 1.092	0.230
80 x 125 (10,000)	5 6 7 8 9	50 x 90 44 x 83 38 x 76 32 x 69 26 x 62	1310.2 1460.9 1581.7 1675.8 1746.3	0.812 0.905 0.980 1.039 1.082	0.230
100 x 125 (12,500)	6 7 8 9 10	64 x 83 58 x 76 52 x 69 46 x 62 40 x 55	1923.1 2102.9 2250.7 2369.7 2463.0	1.192 1.303 1.395 1.469 1.527	0.287
120 x 125 (15,000)	6 7 8 9 10	84 x 83 78 x 76 72 x 69 66 x 62 60 x 55	2385.3 2624.0 2825.5 2993.0 3129.6	1.478 1.626 1.751 1.855 1.940	0.344

$$V = \frac{d(A_1 = 4A_m + A_2)}{162}$$

$A_1$  = Top Area - Square Feet

$V$  = Volume - Cubic Yards

$A_2$  = Bottom Area - Square Feet

$d$  = Depth - Feet

$A_m$  = Area of Cross-section halfway  
between  $A_1$  and  $A_2$  - Sq. Ft.

NOTE: The following formula may be used to compute quantities for excavated ponds not included in this table:

$$V = 1/3 (A_1 + A_2 + \sqrt{A_1 \times A_2}) d/27$$

VOLUME OF EXCAVATION FOR INCREMENTS OF DEPTH OTHER THAN SHOWN MAY BE  
OBTAINED BY STRAIGHT LINE EXTRAPOLATION.

VOLUMES FOUND BY EXTRAPOLATION ARE WITHIN 0.5% OF TRUE COMPUTED VALUES.

Table 11-8. Yardage tables - excavated ponds.

(Sheet 6 of 6)

**4:1 and 2:1 End Slopes and 1:1 Side Slopes**

TOP DIM. FT. (sq. ft.) "ac."	DEPTH (ft.)	BOTTOM DIM. (ft.)	VOLUME (cu. yd.)	TOTAL WATER NEEDS FOR CATTLE (ac.-ft.)				
				60 days	90 days	120 days	180 days	270 days
40 x 40 (1600) "0.037"	4	32 x 16	151.7	0.050	0.028	0.006	-----	-----
	5	30 x 10	166.7	0.059	0.037	0.016	-----	-----
	6	28 x 4	174.2	0.064	0.042	0.020	-----	-----
40 x 60 (2400) "0.055"	4	32 x 36	258.4	0.094	0.061	0.029	-----	-----
	5	30 x 30	296.3	0.118	0.085	0.052	-----	-----
	6	28 x 24	325.3	0.136	0.103	0.070	0.004	-----
	7	26 x 18	346.4	0.149	0.116	0.083	0.017	-----
40 x 75 (3000) "0.069"	4	32 x 51	338.4	0.127	0.086	0.045	-----	-----
	5	30 x 45	393.5	0.162	0.121	0.079	-----	-----
	6	28 x 39	438.7	0.190	0.149	0.107	0.025	-----
	7	26 x 33	474.7	0.212	0.171	0.130	0.047	-----
	8	24 x 27	502.5	0.229	0.188	0.147	0.065	-----
	4	32 x 76	471.7	0.183	0.128	0.073	-----	-----
40 x 100 (4000) "0.092"	5	30 x 70	555.5	0.235	0.180	0.125	0.015	-----
	6	28 x 64	627.6	0.279	0.224	0.170	0.060	-----
	7	26 x 58	688.6	0.317	0.262	0.207	0.098	-----
	8	24 x 52	739.6	0.349	0.294	0.239	0.129	-----
	4	42 x 36	329.5	0.122	0.081	0.040	-----	-----
50 x 60 (3000) "0.069"	5	40 x 30	379.6	0.153	0.112	0.071	-----	-----
	6	38 x 24	418.7	0.177	0.136	0.095	0.013	-----
	7	36 x 18	447.5	0.195	0.154	0.113	0.031	-----
	5	40 x 45	504.6	0.210	0.159	0.107	0.004	-----
50 x 75 (3750) "0.086"	6	38 x 39	565.3	0.248	0.196	0.145	0.042	-----
	7	36 x 33	614.7	0.278	0.227	0.175	0.073	-----
	8	34 x 27	653.6	0.302	0.251	0.199	0.097	-----

Table AL11-9. Excavated pond - alternative design table.

(Sheet 1 of 9)

**4:1 and 2:1 End Slopes and 1:1 Side Slopes**

TOP DIM. FT. (sq. ft.) "ac."	DEPTH (ft.)	BOTTOM DIM. (ft.)	VOLUME (cu. yd.)	TOTAL WATER NEEDS FOR CATTLE (ac.-ft.)				
				60 days	90 days	120 days	180 days	270 days
50 x 90 (4500) "0.103"	5	40 x 60	629.6	0.267	0.205	0.143	0.020	-----
	6	38 x 54	712.0	0.318	0.256	0.195	0.071	-----
	7	36 x 48	781.9	0.361	0.300	0.238	0.114	-----
	8	34 x 42	840.3	0.397	0.336	0.274	0.151	-----
60 x 80 (4800) "0.110"	5	50 x 50	666.7	0.282	0.216	0.150	0.018	-----
	6	48 x 44	752.0	0.334	0.269	0.203	0.071	-----
	7	46 x 38	823.4	0.379	0.313	0.247	0.116	-----
	8	44 x 32	881.8	0.415	0.349	0.283	0.152	-----
60 x 90 (5400) "0.124"	5	50 x 60	768.5	0.328	0.254	0.180	0.032	-----
	6	48 x 54	872.0	0.392	0.318	0.244	0.096	-----
	7	46 x 48	960.8	0.447	0.373	0.299	0.151	-----
	8	44 x 42	1035.9	0.494	0.420	0.346	0.198	-----
60 x 100 (6000) "0.138"	5	50 x 70	870.4	0.375	0.293	0.210	0.046	-----
	6	48 x 64	992.0	0.450	0.368	0.286	0.121	-----
	7	46 x 58	1098.2	0.516	0.434	0.352	0.187	-----
	8	44 x 52	1189.9	0.573	0.491	0.409	0.244	-----
65 x 105 (6825) "0.156"	5	55 x 75	1004.6	0.436	0.342	0.248	0.061	-----
	6	53 x 69	1148.7	0.525	0.431	0.338	0.151	-----
	7	51 x 63	1275.8	0.604	0.510	0.417	0.229	-----
	8	49 x 57	1387.0	0.673	0.579	0.485	0.298	0.018
70 x 100 (7000) "0.161"	5	60 x 70	1027.8	0.445	0.349	0.253	0.061	-----
	6	58 x 64	1174.2	0.536	0.440	0.344	0.152	-----
	7	56 x 58	1303.0	0.616	0.520	0.424	0.232	-----
	8	54 x 52	1415.1	0.685	0.589	0.493	0.301	0.013

Table AL11-9. Excavated pond - alternative design table.

(Sheet 2 of 9)

**4:1 and 2:1 End Slopes and 1:1 Side Slopes**

TOP DIM. FT. (sq. ft.) "ac."	DEPTH (ft.)	BOTTOM DIM. (ft.)	VOLUME (cu. yd.)	TOTAL WATER NEEDS FOR CATTLE (ac.-ft.)				
				60 days	90 days	120 days	180 days	270 days
80 x 100 (8000) "0.184"	5	70 x 70	1185.2	0.515	0.406	0.296	0.077	-----
	6	68 x 64	1356.4	0.621	0.512	0.402	0.183	-----
	7	66 x 58	1507.8	0.715	0.606	0.496	0.277	-----
	8	64 x 52	1640.3	0.797	0.688	0.578	0.359	0.030
90 x 100 (9000) "0.207"	5	80 x 70	1342.6	0.585	0.462	0.339	0.092	-----
	6	78 x 64	1538.7	0.707	0.584	0.460	0.213	-----
	7	76 x 58	1712.7	0.815	0.691	0.568	0.321	-----
	8	74 x 52	1865.5	0.910	0.786	0.663	0.416	0.046
	9	72 x 46	1998.0	0.992	0.868	0.745	0.498	0.128
100 x 100 (10,000) "0.230"	5	90 x 70	1500.0	0.656	0.518	0.381	0.107	-----
	6	88 x 64	1720.9	0.792	0.655	0.518	0.244	-----
	7	86 x 58	1917.5	0.914	0.777	0.640	0.366	-----
	8	84 x 52	2090.7	1.022	0.885	0.747	0.473	0.062
	9	82 x 46	2241.3	1.115	0.978	0.841	0.567	0.155
80 x 125 (10,000) "0.230"	5	70 x 95	1532.4	0.676	0.539	0.401	0.127	-----
	6	68 x 89	1767.6	0.821	0.684	0.547	0.273	-----
	7	66 x 83	1981.0	0.954	0.817	0.679	0.405	-----
	8	64 x 77	2173.6	1.073	0.936	0.799	0.525	0.113
	9	62 x 71	2346.3	1.180	1.043	0.906	0.632	0.220
100 x 125 (12,500) "0.287"	6	88 x 89	2243.1	1.048	0.876	0.705	0.362	-----
	7	86 x 83	2520.3	1.219	1.048	0.877	0.534	0.020
	8	84 x 77	2772.1	1.376	1.204	1.033	0.690	0.176
	9	82 x 71	2999.7	1.517	1.345	1.174	0.831	0.317
	10	80 x 65	3203.7	1.643	1.472	1.300	0.957	0.443
120 x 125 (15,000) "0.344"	6	108 x 89	2718.7	1.274	1.068	0.863	0.451	-----
	7	106 x 83	3059.5	1.485	1.279	1.074	0.662	0.046
	8	104 x 77	3370.7	1.678	1.472	1.267	0.855	0.238
	9	102 x 71	3653.0	1.853	1.647	1.442	1.030	0.413
	10	100 x 65	3907.4	2.011	1.805	1.599	1.188	0.517

Table AL11-9. Excavated pond - alternative design table.

(Sheet 3 of 9)

## 4:1 and 3:1 End Slopes and 2:1 Side Slopes

TOP DIM. FT. (sq. ft.) "ac."	DEPTH (ft.)	BOTTOM DIM. (ft.)	VOLUME (cu. yd.)	TOTAL WATER NEEDS FOR CATTLE (ac.-ft.)				
				60 days	90 days	120 days	180 days	270 days
40 x 40 (1600) "0.037"	4	24 x 12	128.8	0.036	0.014	-----	-----	-----
	5	20 x 5	135.8	0.040	0.018	-----	-----	-----
40 x 60 (2400) "0.055"	4	24 x 32	223.6	0.073	0.040	0.007	-----	-----
	5	20 x 25	246.9	0.087	0.054	0.021	-----	-----
	6	16 x 18	261.3	0.096	0.063	0.030	-----	-----
	7	12 x 11	268.9	0.101	0.068	0.035	-----	-----
40 x 75 (3000) "0.069"	4	24 x 47	294.7	0.100	0.059	0.018	-----	-----
	5	20 x 40	330.2	0.122	0.081	0.040	-----	-----
	6	16 x 33	354.7	0.138	0.096	0.055	-----	-----
	7	12 x 26	370.0	0.147	0.106	0.065	-----	-----
	8	8 x 19	378.5	0.152	0.111	0.070	-----	-----
40 x 100 (4000) "0.092"	4	24 x 72	413.2	0.146	0.092	0.037	-----	-----
	5	20 x 65	469.1	0.181	0.126	0.071	-----	-----
	6	16 x 58	510.2	0.207	0.152	0.097	-----	-----
	7	12 x 51	538.6	0.224	0.169	0.114	0.005	-----
	8	8 x 44	556.2	0.235	0.180	0.125	0.016	-----
50 x 60 (3000) "0.069"	4	34 x 32	291.8	0.099	0.057	0.016	-----	-----
	5	30 x 25	325.6	0.120	0.078	0.037	-----	-----
	6	26 x 18	348.0	0.133	0.092	0.051	-----	-----
	7	22 x 11	361.0	0.141	0.100	0.059	-----	-----
50 x 75 (3750) "0.086"	5	30 x 40	436.7	0.168	0.116	0.065	-----	-----
	6	26 x 33	474.7	0.191	0.140	0.089	-----	-----
	7	22 x 26	501.0	0.208	0.156	0.105	0.002	-----
	8	18 x 19	517.7	0.218	0.167	0.115	0.012	-----

Table AL11-9. Excavated pond - alternative design table.

**4:1 and 3:1 End Slopes and 2:1 Side Slopes**

TOP DIM. FT. (sq. ft.) "ac."	DEPTH (ft.)	BOTTOM DIM. (ft.)	VOLUME (cu. yd.)	TOTAL WATER NEEDS FOR CATTLE (ac.-ft.)				
				60 days	90 days	120 days	180 days	270 days
50 x 90 (4500) "0.103"	5	30 x 55	547.8	0.216	0.154	0.093	-----	-----
	6	26 x 48	601.3	0.249	0.188	0.126	0.003	-----
	7	22 x 41	641.0	0.274	0.212	0.151	0.027	-----
	8	18 x 34	668.8	0.291	0.229	0.168	0.044	-----
60 x 80 (4800) "0.110"	5	40 x 45	589.5	0.234	0.168	0.102	-----	-----
	6	36 x 38	648.0	0.270	0.204	0.138	0.007	-----
	7	32 x 31	691.5	0.297	0.231	0.165	0.034	-----
	8	28 x 24	722.2	0.316	0.250	0.184	0.053	-----
60 x 90 (5400) "0.124"	5	40 x 55	682.1	0.275	0.201	0.127	-----	-----
	6	36 x 48	754.7	0.320	0.246	0.172	0.024	-----
	7	32 x 41	810.8	0.354	0.280	0.206	0.058	-----
	8	28 x 34	852.5	0.380	0.306	0.232	0.084	-----
60 x 100 (6000) "0.138"	5	40 x 65	774.7	0.316	0.233	0.151	-----	-----
	6	36 x 58	861.3	0.369	0.287	0.205	0.040	-----
	7	32 x 51	930.0	0.412	0.330	0.247	0.083	-----
	8	28 x 44	982.9	0.445	0.362	0.280	0.116	-----
65 x 105 (6825) "0.156"	5	45 x 70	902.0	0.372	0.278	0.185	-----	-----
	6	41 x 63	1008.0	0.438	0.344	0.251	0.063	-----
	7	37 x 56	1094.0	0.491	0.397	0.304	0.117	-----
	8	33 x 49	1162.2	0.533	0.440	0.346	0.159	-----
70 x 100 (7000) "0.161"	5	50 x 65	927.5	0.383	0.287	0.191	-----	-----
	6	56 x 58	1036.9	0.451	0.355	0.259	0.067	-----
	7	52 x 51	1125.8	0.506	0.410	0.314	0.122	-----
	8	48 x 44	1196.2	0.550	0.454	0.358	0.166	-----

(210-VI-NEH, Amend. AL4, November 2006)

AL11-60(41)

Table AL11-9. Excavated pond - alternative design table.

(Sheet 5 of 9)

## 4:1 and 3:1 End Slopes and 2:1 Side Slopes

(210-VI-NEH, Amend. AL4, November 2006)

TOP DIM. FT. (sq. ft.) "ac."	DEPTH (ft.)	BOTTOM DIM. (ft.)	VOLUME (cu. yd.)	TOTAL WATER NEEDS FOR CATTLE (ac.-ft.)				
				60 days	90 days	120 days	180 days	270 days
80 x 100 (8000) "0.184"	5	60 x 65	1080.2	0.450	0.341	0.231	0.011	-----
	6	56 x 58	1212.4	0.532	0.422	0.313	0.093	-----
	7	52 x 51	1321.5	0.600	0.490	0.380	0.161	-----
	8	48 x 44	1409.6	0.654	0.545	0.435	0.216	-----
90 x 100 (9000) "0.207"	5	70 x 65	1233.0	0.517	0.394	0.271	0.024	-----
	6	66 x 58	1388.0	0.614	0.490	0.367	0.120	-----
	7	62 x 51	1517.3	0.694	0.570	0.447	0.200	-----
	8	58 x 44	1622.9	0.759	0.636	0.512	0.266	-----
	9	54 x 37	1707.0	0.811	0.688	0.564	0.318	-----
100 x 100 (10,000) "0.230"	5	80 x 65	1385.8	0.585	0.448	0.311	0.036	-----
	6	76 x 58	1563.6	0.695	0.558	0.421	0.147	-----
	7	72 x 51	1713.0	0.788	0.650	0.513	0.239	-----
	8	68 x 44	1836.2	0.864	0.727	0.590	0.316	-----
	9	64 x 37	1935.3	0.925	0.788	0.651	0.377	-----
80 x 125 (10,000) "0.230"	5	60 x 90	1404.3	0.596	0.459	0.322	0.048	-----
	6	56 x 83	1590.2	0.711	0.574	0.437	0.163	-----
	7	52 x 76	1749.3	0.810	0.673	0.536	0.262	-----
	8	48 x 69	1883.7	0.893	0.756	0.619	0.345	-----
	9	44 x 62	1995.3	0.963	0.825	0.688	0.414	0.003
100 x 125 (12,500) "0.287"	6	76 x 83	2052.4	0.929	0.758	0.587	0.244	-----
	7	72 x 76	2270.4	1.065	0.893	0.722	0.379	-----
	8	68 x 69	2458.5	1.181	1.010	0.838	0.496	-----
	9	64 x 62	2618.7	1.280	1.109	0.938	0.595	0.081
	10	60 x 55	2753.1	1.364	1.192	1.021	0.678	0.164
120 x 125 (15,000) "0.344"	6	96 x 83	2514.7	1.147	0.942	0.736	0.325	-----
	7	92 x 76	2791.5	1.319	1.113	0.908	0.496	-----
	8	88 x 69	3033.3	1.469	1.263	1.058	0.646	0.029
	9	84 x 62	3242.0	1.598	1.393	1.187	0.776	0.159
	10	80 x 55	3419.8	1.708	1.503	1.297	0.886	0.269

Table AL11-9. Excavated pond - alternative design table.

**4:1 and 3:1 End Slopes and 3:1 Side Slopes**

TOP DIM. FT. (sq. ft.) "ac."	DEPTH (ft.)	BOTTOM DIM. (ft.)	VOLUME (cu. yd.)	TOTAL WATER NEEDS FOR CATTLE (ac.-ft.)				
				60 days	90 days	120 days	180 days	270 days
40 x 40 (1600) "0.037"	4	16 x 12	116.1	0.028	0.006	-----	-----	-----
	5	10 x 5	120.4	0.031	0.009	-----	-----	-----
40 x 60 (2400) "0.055"	4	16 x 32	199.1	0.058	0.025	-----	-----	-----
	5	10 x 25	213.0	0.066	0.033	-----	-----	-----
	6	4 x 18	218.7	0.070	0.037	0.004	-----	-----
40 x 75 (3000) "0.069"	4	16 x 47	261.3	0.080	0.039	-----	-----	-----
	5	10 x 40	282.4	0.093	0.052	0.011	-----	-----
	6	4 x 33	292.0	0.099	0.058	0.016	-----	-----
40 x 100 (4000) "0.092"	4	16 x 72	365.0	0.117	0.062	0.007	-----	-----
	5	10 x 65	398.1	0.137	0.082	0.027	-----	-----
	6	4 x 58	414.2	0.147	0.092	0.037	-----	-----
50 x 60 (3000) "0.069"	4	26 x 32	267.3	0.083	0.042	0.001	-----	-----
	5	20 x 25	291.7	0.099	0.057	0.016	-----	-----
	6	14 x 18	305.3	0.107	0.066	0.025	-----	-----
	7	8 x 11	311.4	0.111	0.070	0.028	-----	-----
50 x 75 (3750) "0.086"	5	20 x 40	388.9	0.138	0.087	0.035	-----	-----
	6	14 x 33	412.0	0.153	0.101	0.050	-----	-----
		8 x 26	424.1	0.160	0.109	0.057	-----	-----
50 x 90 (4500) "0.103"	5	20 x 55	486.1	0.178	0.116	0.055	-----	-----
	6	14 x 48	518.7	0.198	0.136	0.075	-----	-----
	7	8 x 41	536.9	0.209	0.148	0.086	-----	-----
60 x 80 (4800) "0.110"	5	30 x 45	537.0	0.201	0.135	0.070	-----	-----
	6	24 x 38	578.7	0.227	0.161	0.095	-----	-----
	7	18 x 31	605.6	0.244	0.178	0.112	-----	-----
	8	12 x 24	621.0	0.253	0.188	0.122	-----	-----

(210-VI-NEH, Amend. AL4, November 2006)

AL11-60(43)

Table AL11-9. Excavated pond - alternative design table.

(Sheet 7 of 9)

## 4:1 and 3:1 End Slopes and 3:1 Side Slopes

TOP DIM. FT. (sq. ft.) "ac."	DEPTH (ft.)	BOTTOM DIM. (ft.)	VOLUME (cu. yd.)	TOTAL WATER NEEDS FOR CATTLE (ac.-ft.)				
				60 days	90 days	120 days	180 days	270 days
60 x 90 (5400) "0.124"	5	30 x 55	620.4	0.236	0.162	0.088	-----	-----
	6	24 x 48	672.0	0.268	0.194	0.120	-----	-----
	7	18 x 41	706.7	0.290	0.216	0.142	-----	-----
	8	12 x 34	727.7	0.303	0.229	0.155	0.007	-----
60 x 100 (6000) "0.138"	5	30 x 65	703.7	0.272	0.189	0.107	-----	-----
	6	24 x 58	765.3	0.310	0.228	0.145	-----	-----
	7	18 x 51	807.9	0.336	0.254	0.172	0.007	-----
	8	12 x 44	834.4	0.353	0.270	0.188	0.024	-----
65 x 105 (6825) "0.157"	5	35 x 70	826.4	0.325	0.232	0.138	-----	-----
	6	29 x 63	905.3	0.374	0.280	0.187	-----	-----
	7	23 x 56	962.8	0.410	0.316	0.222	0.035	-----
	8	17 x 49	1001.8	0.434	0.340	0.247	0.059	-----
70 x 100 (7000) "0.161"	5	40 x 65	856.5	0.339	0.243	0.147	-----	-----
	6	34 x 58	940.9	0.391	0.295	0.199	0.007	-----
	7	28 x 51	1003.6	0.430	0.334	0.238	0.046	-----
	8	22 x 44	1047.7	0.457	0.361	0.266	0.074	-----
80 x 100 (8000) "0.184"	5	50 x 65	1009.2	0.406	0.297	0.187	-----	-----
	6	44 x 58	1116.4	0.473	0.363	0.253	0.034	-----
	7	38 x 51	1199.3	0.524	0.414	0.305	0.085	-----
	8	32 x 44	1261.0	0.562	0.453	0.343	0.124	-----
90 x 100 (9000) "0.207"	5	60 x 65	1162.0	0.473	0.350	0.227	-----	-----
	6	54 x 58	1292.0	0.554	0.431	0.307	0.060	-----
	7	48 x 51	1395.1	0.618	0.495	0.371	0.124	-----
	8	42 x 44	1474.4	0.667	0.544	0.420	0.174	-----
	9	36 x 37	1533.0	0.703	0.580	0.457	0.210	-----

Table AL11-9. Excavated pond - alternative design table.

**4:1 and 3:1 End Slopes and 3:1 Side Slopes**

TOP DIM. FT. (sq. ft.) "ac."	DEPTH (ft.)	BOTTOM DIM. (ft.)	VOLUME (cu. yd.)	TOTAL WATER NEEDS FOR CATTLE (ac.-ft.)				
				60 days	90 days	120 days	180 days	270 days
100 x 100 (10,000) "0.230"	5	70 x 65	1314.8	0.541	0.404	0.267	-----	-----
	6	64 x 58	1467.6	0.635	0.498	0.361	0.087	-----
	7	58 x 51	1590.8	0.712	0.575	0.438	0.163	-----
	8	52 x 44	1687.7	0.772	0.635	0.498	0.223	-----
	9	46 x 37	1761.3	0.818	0.680	0.543	0.269	-----
80 x 125 (10,000) "0.230"	5	50 x 90	1310.2	0.538	0.401	0.264	-----	-----
	6	44 x 83	1460.9	0.631	0.494	0.357	0.083	-----
	7	38 x 76	1581.7	0.706	0.569	0.432	0.158	-----
	8	32 x 69	1675.8	0.765	0.627	0.490	0.216	-----
	9	26 x 62	1746.3	0.808	0.671	0.534	0.260	-----
100 x 125 (12,500) "0.287"	6	64 x 83	1923.1	0.849	0.678	0.506	0.164	-----
	7	58 x 76	2102.9	0.961	0.789	0.618	0.275	-----
	8	52 x 69	2250.7	1.052	0.881	0.710	0.367	-----
	9	46 x 62	2369.7	1.126	0.955	0.783	0.441	-----
	10	40 x 55	2463.0	1.184	1.012	0.841	0.498	-----
120 x 125 (15,000) "0.344"	6	84 x 83	2385.3	1.067	0.862	0.656	0.245	-----
	7	78 x 76	2624.0	1.215	1.009	0.804	0.392	-----
	8	72 x 69	2825.5	1.340	1.134	0.929	0.517	-----
	9	66 x 62	2993.0	1.444	1.238	1.033	0.621	0.004
	10	60 x 55	3129.6	1.529	1.323	1.117	0.706	0.089

Table AL11-9. Excavated pond - alternative design table.

(Sheet 9 of 9)